Department for
Business, Energy
& Industrial Strategy

The United Kingdom's Seventh National Report on Compliance with the Obligations of the Joint Convention on the Safety of Spent Fuel and on the Safety of Radioactive Waste Management

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Contributors to the United Kingdom's National Report

The Office for Nuclear Regulation prepared this report on behalf of the Department for Business, Energy and Industrial Strategy (BEIS) and in consultation with, and incorporating contributions, from:

- UK Government (BEIS) and devolved administrations (Scottish Government, Welsh Government, Northern Ireland Executive)
- Home Office
- Environment agencies (Environment Agency, Scottish Environment Protection Agency, National Resources Wales and Northern Ireland Environment Agency)
- Civil Aviation Authority
- Dounreay Site Restoration Limited
- EDF Nuclear Generation Limited
- Food Standards Agency and Food Standards Scotland
- Low Level Waste Repository Limited
- Magnox Limited
- Maritime and Coastguard Agency
- Nuclear Decommissioning Authority
- Public Health England
- Radioactive Waste Management Limited
- Sellafield Limited

Any enquiries regarding this publication should be sent to us at:
enquiries@beis.gov.uk

Foreword

The United Kingdom (UK) remains firmly committed to meeting its obligations under the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management. This, our seventh National Report, provides a comprehensive update of progress made since the last Review Meeting (RM) in safely managing our radioactive waste and spent fuel, and we welcome this peer review of our activities.

The UK has for more than 70 years accumulated radioactive waste and spent fuel as a result of operating nuclear facilities across the entire nuclear fuel cycle, and from other applications of ionising radiation. Dealing with our existing and future waste inventory will continue to offer significant challenges as we decommission redundant facilities and handle, treat and store accumulated higher activity wastes and spent fuel, as well as continuing to add to our inventory from continued nuclear and other operations. All of the higher activity waste is being stored safely above ground, pending its future management in line with national policies (disposal in a geological disposal facility in England or Wales, or management in near surface facilities in Scotland). Any spent fuel remaining after reprocessing ends and future accumulations will be stored safely, pending a decision on its disposition. The large volume of low level radioactive waste generated continues to be disposed of through well-established disposal routes provided by the low level waste repository and the supply chain. The UK approach to managing our radioactive waste inventory is a sustainable one, which, amongst other things, aims to avoid placing undue burdens upon future generations.

The Nuclear Decommissioning Authority (NDA) is a public body sponsored by the UK government’s Department for Business, Energy & Industrial Strategy (BEIS), and is legally responsible for securing the decommissioning and clean-up of much of the UK’s civil nuclear liabilities. Consequently, the NDA is responsible for securing the majority of the decommissioning and safe management of radioactive waste in the UK. The NDA establishes the overall strategy, allocates budgets, sets targets and monitors progress, but it does not undertake clean-up operations of its facilities directly. The NDA mission on its sites is delivered through six companies who hold nuclear site licences granted by the Office for Nuclear Regulation (ONR) as well as permits and authorisations issued by the relevant environment agency (Environment Agency in England, Natural Resources Wales and the Scottish Environment Protection Agency). These licensed entities have primary responsibility for safety and environmental protection under the law and must demonstrate that they are meeting relevant good practice to minimise risks to people and the environment.

The principal independent regulators for the purposes of the Joint Convention are the ONR and the national environment agencies for England, Scotland, Wales and Northern Ireland.

The UK continues to spend considerable sums of money to clean-up our civil nuclear liabilities. This is clearly illustrated by the NDA’s planned expenditure of approximately £3.4 billion in the financial year 2020/21. Overall costs for the UK are estimated to be approximately £131 billion (discounted cost) over the next 100 years, using existing approaches to decommissioning and for managing spent fuel and radioactive waste. This figure does not include money being spent on decommissioning and waste management by licensed operators and other radioactive waste producers, who are not part of the NDA’s estate, nor does it include dealing with all of the accumulated defence related nuclear waste.

This report also provides the UK’s response to the feedback given to all Contracting Parties at the sixth RM. These include addressing the following overarching issues outlined in the Summary Report, namely: -

- Implementation of national strategies for spent fuel and radioactive waste management;
- Safety implications of long-term management of spent fuel;
- Linking long-term management and disposal of disused sealed radioactive sources; and
- Remediation of legacy sites and facilities.

In addition, the Rapporteur's report for Country Group 4 identified a specific challenge associated with the UK's withdrawal from Euratom. On 31 January 2020, the UK formally left the European Union and Euratom, entering a transition period which will end on 31 December 2020. Measures have been implemented to enable the nuclear industry to continue to operate to high safety and environmental protection standards, and specific aspects directly relevant to the Joint Convention have been mentioned in this report.

There were also some ongoing challenges for the UK identified in the Rapporteur's report, these are as follows: -

- Continued remediation of high-hazard facilities at Sellafield;
- Decommissioning the fleet of shutdown Magnox nuclear power plants:
- Identifying a suitable site for a geological disposal facility;
- Maintenance of the spent fuel and radioactive waste management infrastructure; and
- Sustaining the nuclear skills base (particularly for decommissioning).

The UK continues to make good progress in respect of the ongoing challenges and identified issues from the last RM. In particular, progress is being made with the remediation of high-hazard legacy facilities at the Sellafield site, but it will take many decades to complete the work. Although decommissioning is underway on the fleet of shutdown Magnox nuclear power plant sites, this work will also take decades to complete. In addition, some of the operating reactors are making plans for defueling and decommissioning when they finally shutdown, which is currently planned to take place from 2023. Several other licensed nuclear sites are being systematically decommissioned and cleaned up to the point where they can eventually be restored for re-use. Notably, one licensed nuclear site was released from regulatory control for re-use in December 2019.

The UK works closely with its counterparts in other countries to ensure its approaches reflect international good practice and capture lessons learnt from experience elsewhere. The UK hosted a full scope Integrated Regulatory Review Service mission in October 2019. The UK remains keen to share its experience with other Contracting Parties.

This report demonstrates that the UK's approach to safety and environmental protection relevant to the management of radioactive wastes and spent fuel is well-established, effective, and drives sustained improvements, clearly meeting the requirements of the Joint Convention.

Contents

List of tables:

List of Figures:

Section A – Introduction

A.1. This, the seventh United Kingdom (UK) National Report (NR) updates the sixth report published in October 2017 and is aimed at demonstrating compliance with the obligations of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereinafter referred to as the 'JC'). It is intended to provide a comprehensive update of progress made since the last Review Meeting (RM) in safely managing the UK's radioactive waste and spent fuel and presents the measures in place to ensure continued compliance with the obligations of the JC. The report covers the period from October 2017 to May 2020. Any significant developments after this date will be included in the UK presentation during the seventh RM in 2021.

Structure of the Report

A.2. The structure of this report follows the guidelines on the form and structure of national reports (INFCIRC/604/Rev 3) and is the same as that used in the sixth UK NR [1]. It is intended to be a stand-alone document, providing sufficient background information on UK policies and practices and the legislative and regulatory framework to enable the reader to gain adequate understanding of the safe management of spent fuel and radioactive waste in the UK.

A.3. However, given that these aspects are mature there are many areas where the means of compliance with the JC has not changed since the last report, or even prior to this. To aid other Contracting Parties' peer reviewers, who may have seen this information on one or more occasions, the main report includes an overview of the means of compliance and makes reference to more detailed information provided in Section L - Annexes or by hyperlinking to other publicly-available documents. The resulting report places more emphasis on what has changed or significantly progressed in the 3 years since the last report and in presenting tangible examples of delivery of safe management of spent fuel and radioactive waste in the UK nuclear industry. In particular, progress made in reducing hazard and risk at Sellafield, and at other nuclear sites undergoing decommissioning and generating radioactive waste is emphasised.

A.4. Where the means of compliance has changed or where there has been particular progress or success, the relevant text is identified at the beginning of the relevant section or Article. It is then highlighted in the main text with a surrounding box as with this paragraph.

Title

A.5. In addition to describing how compliance with the JC has been achieved, this report also illustrates the practical application of safe spent fuel and radioactive waste management practices and approaches. The most prominent examples of successes, areas of progress against challenges or work which UK regulators and industry regard as noteworthy, are highlighted as case studies in the same format as this paragraph.

Survey of the main developments since the sixth UK National Report

A.6. Within this section, the most significant developments since the publication of the sixth UK NR are summarised under the following headings:

- Changes in applicable laws, regulations and practices;
- Update on major programmes, safety and environmental issues; and
- Identified future challenges and developments.

A.7. The summaries provide the main highlights, with clear links to the sections of the report where further detail is presented.

Changes in Applicable Laws, Regulations and Practices

A.8. The applicable laws and regulations are largely unchanged since the sixth UK NR. It is worth reiterating that there are some differences in applicable legislation policies and practices between the four countries that make up the UK. These have been highlighted in previous national reports and are mentioned where relevant in this report. There have been some changes to laws, mainly as a result of the implementation of the EU Basic Safety Standards Directive (2013/59/Euratom) and new regulations coming into force in Scotland. The most significant changes are:

- Introduction of the Ionising Radiations Regulations 2017 (IRR17) and the Ionising Radiations Regulations (Northern Ireland) 2017 (IRRNI17) – replacing the 1999 regulations;
- Updates to the Environmental Permitting (England and Wales) Regulations 2016 (EPR16) - amended in 2018;
- Introduction of the Environmental Authorisations (Scotland) Regulations 2018 (EASR18), which provide an integrated authorisation framework for radioactive substances in Scotland, replacing the Radioactive Substances Act 1993 (RSA93);
- Introduction of the Radiation (Emergency Preparedness and Public Information) Regulations 2019 (REPPIR19) (replacing REPPIR2001) covering preparedness and response to radiation emergencies, along with an Approved Code of Practice (ACoP);
- Amendments to the Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations (EIADR), to bring it in line with its parent EU directive;
- A significant step forward on implementing a GDF was made with the publication of an update to government policy (‘Implementing Geological Disposal – Working with Communities’) setting out a consent-based approach to siting a GDF in England based around close partnership with communities. Welsh Government has also published its equivalent policy (Geological Disposal of Higher Activity Radioactive Waste: Working with Communities);
- Progress to improve the regulation of the final stages of nuclear site decommissioning and clean up; and
- Progress with the development and implementation of integrated waste strategies, to optimise waste management at site- and national-level.

Update on Major Programmes, Safety and Environmental Issues

A.9. The UK continues to make good progress in respect of the ongoing challenges and identified issues from the last RM. Particularly notable areas of progress and success include:

- Continued work to facilitate the remediation of high hazard legacy facilities, cooling and storage ponds i.e. pools (Pile Fuel Storage Pond and First Generation Magnox Storage Pond) and silos (Magnox Swarf Storage Silo and Pile Fuel Cladding Silo) at Sellafield;
- Completion of transfer and consolidation of Dounreay plutonium inventory at Sellafield;
- Completion of defueling and verification of fuel free status at the last two Magnox nuclear power stations at Calder Hall and Wylfa;

- Entry of Bradwell nuclear power station into an extended period (~70 years) of 'Care and Maintenance' (C&M), the first UK nuclear power station to achieve this stage of decommissioning;
- Completion of a significant programme to decommission five legacy buildings used to store plutonium-contaminated material (PCM) at the Low Level Waste Repository (LLWR);
- Successful completion of the reprocessing contracts to customers at the Thermal Oxide Reprocessing Plant (THORP) at Sellafield after 24 years of successful operation;
- Publication and progress in the implementation of new requirements at all UK nuclear sites for the delivery of optimised waste management and site clean-up during final decommissioning and clean-up;
- Final site clean-up and revocation of the nuclear site licence from the former GE Healthcare radiopharmaceuticals site in Cardiff, Wales; the site will be now be re-used for non-nuclear purposes; and
- The UK hosted a full scope Integrated Regulatory Review Service (IRRS) mission in October 2019.

Identified Future Challenges and Developments

A.10. The UK nuclear industry continues to make good progress with the challenges of remediating legacy nuclear facilities. In particular, the retrieval of radioactive waste inventory from high hazard legacy ponds and silos at Sellafield remains one of the highest priority areas of activity. There has been progress in retrieval of spent fuel and radioactive wastes from legacy ponds into more modern storage conditions, and the capability to retrieve wastes from Magnox Swarf Storage Silo (MSSS) and Pile Fuel Cladding Silo (PFCS) is expected to be implemented within the next year. This work will contribute to reducing the hazard and risk of these facilities over the next three years and beyond.

A.11. Sellafield is anticipating completion of its final reprocessing operations in 2020/21. The end of reprocessing at the Magnox Reprocessing Plant follows the cessation of operations at THORP in 2018. As a result, the focus of the Sellafield mission will move to decommissioning, radioactive waste and spent fuel storage, site clean-up and environmental remediation.

A.12. The programme of work to decommission the fleet of defueled Magnox nuclear power stations continues to make steady progress. These are being decommissioned to an agreed end-state, building on the experience obtained from taking the Bradwell site into an extended period (lasting several decades) of C&M. The NDA and Magnox Ltd have amended the generic approach of placing all of the Magnox reactors into a period of C&M. Work is now underway to take into account site-specific factors that are likely to result in revised decommissioning programmes at each site. As part of this strategic review, it is possible that some sites will now be progressed to their end-states in shorter timescales (e.g. 10-20 years).

A.13. Further progress has been made to de-fuel the original Dounreay Fast Reactor (DFR), remove the alkali metal and transport the fuel to Sellafield for reprocessing alongside the Magnox fuel. The defueling is more than 50% complete and significant progress has been made in remote cutting of the reactor top plate to release some stuck breeder fuel elements.

A.14. On 31 January 2020, the UK formally left the European Union (EU) and Euratom. The UK is now in the Transition Period which will end on 31 December 2020 and is currently engaged in negotiations with the European Commission (EC) on the terms of the future civil nuclear cooperation. Under the Northern Ireland Protocol within the UK-EU Withdrawal Agreement, Northern Ireland will continue to apply specific EU rules concerning standards and regulations for goods. This will not result in any substantive changes in the UK's management of spent fuel and radioactive waste management and requires a Statutory Instrument (SI) to give it effect. Under the civil nuclear provisions in the Withdrawal Agreement Article 83(3), an SI is also required to deal with certain types of fissile material in the UK that belongs to EU Member States.

Section B - Policies and Practices

<u>Article 32.1:</u> In accordance with the provisions of Article 30, each Contracting Party shall submit a national report to each review meeting of Contracting Parties. This report shall address the measures taken to implement each of the obligations of the Convention. For each Contracting Party, the report shall also address its:

(i) Spent fuel management policy;

(ii) Spent fuel management practices;

(iii) Radioactive waste management policy;

(iv) Radioactive waste management practices;

(v) Criteria used to define and categorise radioactive waste.

B.1. The policies and practices for spent fuel and radioactive waste management are presented in this section. These have not changed substantively since the sixth and earlier UK NRs, with the exception of the UK signalling its intention to cease all spent fuel reprocessing in the near-future.

B.2. The following developments since the sixth UK NR are notable:

- The thermal oxide spent fuel reprocessing plant at Sellafield ceased operating in November 2018 after fulfilling its reprocessing contracts;
- Publication of the UK government's updated policy framework for implementing geological disposal as set out in '*Implementing Geological Disposal - Working with Communities. An updated framework for the long-term management of higher activity radioactive waste*' (December 2018). This replaces the 2014 White Paper, *Implementing Geological Disposal*, in England. Welsh Government has also published its equivalent policy (*Geological Disposal of Higher Activity Radioactive Waste: Working with Communities*, January 2019);
- Progress in the Magnox Operating Programme (MOP) and reprocessing of spent Magnox fuel at Sellafield;
- Progress to improve the regulation of the final stages of nuclear site decommissioning and clean up;
- The decommissioning strategy for Magnox nuclear power stations was changed to move away from placing all sites in an extended period of quiescence, to adopting site-specific decommissioning approaches which may result in some sites being decommissioned earlier than anticipated;
- Progress on the use of integrated waste management. Publication of the NDA Radioactive Waste Strategy;
- Proposals to exclude disposal sites for Low-level radioactive Waste (LLW) and Very-Low level radioactive Waste (VLLW) from the requirements of the Paris-Brussels Convention; and
- The UK government has initiated work to update and consolidate its policy framework for nuclear decommissioning and radioactive substances. In due course a public consultation document will be launched on the government's website.

B.3. The extant policies and practices are described in more detail in the text below. In addition, the approaches being taken to address some key issues within the UK nuclear industry are highlighted under the general themes of optimising waste management; management of legacy facilities and wastes; knowledge management; and innovation and shared learning.

Criteria to Define and Categorise Radioactive Waste (Article 32.1(v))

B.4. Radioactive waste is defined in EPR16 (for England and Wales) [2], EASR18 (for Scotland) [3] and RSA93 (for Northern Ireland) [4]. The definitions presented in these pieces of legislation can be summarised to define radioactive waste as a substance, article or object that is waste, i.e. it has no further use and will be disposed of or discarded, and that contains radionuclides above radionuclide-specific threshold levels that are defined in the legislation.

Radioactive waste is generally classified based on its level of radioactivity and degree of heat generation [5] [6]. The categories of radioactive waste used in the UK are VLLW, LLW, Intermediate-level radioactive Waste (ILW) and High-level radioactive Waste (HLW) (Figure 1: Radioactive waste categories used in the UK

B.5. Figure 1): HLW and ILW differ in terms of heat generation. HLW, typically the Highly Active Liquor (HAL) by-product from the reprocessing of spent fuel, is sufficiently radioactive that it generates a significant amount of heat (typically thermal power above about 2kW/m^3) which has to be taken into account for its storage and disposal.

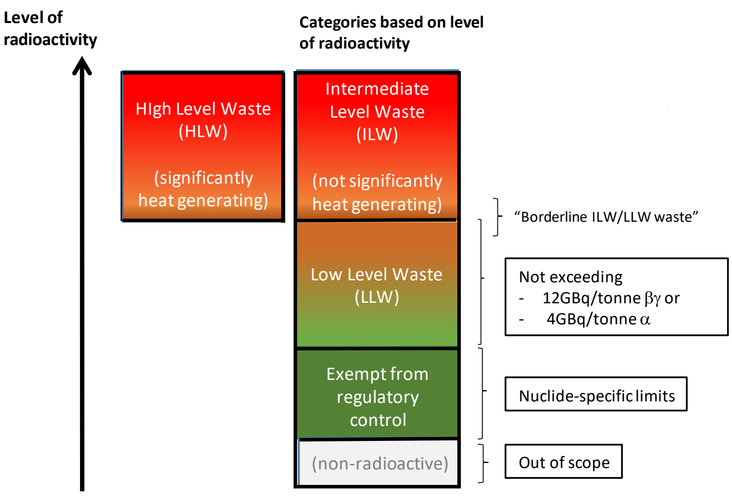


Figure 1: Radioactive waste categories used in the UK

B.6. LLW is categorised as that having radioactive content not exceeding 4 GBq/tonne of alpha activity, or 12 GBq/tonne of beta/gamma activity. Very Low Level Waste (VLLW) is a sub-category of LLW, which can be safely disposed of alongside municipal, commercial or industrial waste, or at permitted landfill facilities, subject to defined limits on radioactivity content (defined in the specific waste acceptance criteria for each landfill facility). Collectively, LLW and VLLW are often referred to as Lower Activity Waste (LAW). Some radioactive waste can be exempt from regulatory control because its levels of radioactivity fall below thresholds defined in legislation and disposal of such waste does not require a permit or authorisation from the environment agencies (although it may be subject to other regulation due to its non-radiological properties).

B.7. Higher Activity radioactive Waste (HAW) [6] is a collective term for waste inclusive of HLW, ILW, and small amounts of LLW that is not suitable for disposal in existing LLW disposal facilities because of its particular chemical, physical or radiological properties. HAW will be managed in the long-term through geological disposal in England and/or Wales, or managed (where appropriate) in near-surface facilities in Scotland.

B.8. Borderline (or boundary) waste is a term often used to describe waste which has a level of radioactivity around the boundary between two waste categories, typically LLW and ILW. This may provide opportunities for optimised management of such waste, for example segregation into separate waste streams or decay storage, enabling disposal through an appropriate route. Some cases where this has been carried out in relation to borderline ILW / LLW are described below.

B.9. Spent fuel and some nuclear materials (separated plutonium and uranium) are not currently classified as waste. If in the future it is decided these materials have no further use, they will be declared as radioactive waste, and managed as such. To ensure that the geological disposal of these materials would be possible if deemed appropriate, Radioactive Waste Management Ltd (RWM), the body responsible for delivery of a geological disposal facility (GDF), has included a defined volume of UK spent fuel and nuclear materials in its planning assumptions for the inventory that may be disposed of in a GDF.

Spent Fuel Management Policy (Article 32.1(i))

B.10. In the UK, the question of whether spent fuel should be reprocessed, or alternative spent fuel management options be adopted, is to be assessed by the owners (which can be different from the operator of the storage facility) of the spent fuel, subject to them meeting all appropriate legal and regulatory requirements. The UK government believes that spent fuel should not be categorised as a radioactive waste so long as the option of reprocessing remains open and a practicable future use for the fuel is foreseen. However, the government is currently not expecting any proposals to reprocess spent fuel from proposed new nuclear power plants in the UK and therefore spent fuel from these power stations may be designated as HAW in due course.

B.11. The UK government supports the construction of new nuclear power stations in England and Wales (but this is not supported by Scottish Government, which is focussed on the development of renewable and other low / zero carbon energy sources to provide Scotland's long-term energy needs). The UK government's policy is that, before development consents for new nuclear power stations are granted, it will need to be satisfied that effective arrangements exist or will exist to manage and dispose of the wastes they will produce. There are no proposals to build any new facilities to reprocess the spent fuel arising from either existing or new nuclear power plants. The new nuclear power station being built at Hinkley Point C (HPC) is proceeding on the basis that the resulting spent fuel will not be reprocessed. This is also the case for the only operating Pressurised Water Reactor (PWR) at Sizewell B. Plans for handling and storage of spent fuel, and financing of, radioactive waste management in the future are proceeding on this basis. The UK government concluded that it is technically possible to dispose of future HAW in a GDF and that this is a viable solution and the right approach for managing waste from any new nuclear power stations, including spent fuel.

B.12. In 2018, the UK government's policy document 'Implementing Geological Disposal – Working With Communities' [7] confirmed that the current policy remains valid. Disposability assessment of the radioactive waste and spent fuel expected to arise from the new reactors proposed for sites in England and Wales has been conducted by RWM. It was concluded that, given a disposal site with suitable characteristics, the waste would be disposable.

Spent Fuel Management Practices (Article 32.1(ii))

B.13. The UK manages a diverse range of spent fuel and associated materials, including the plutonium and uranium separated from spent fuel. These principally arise from decades of operation of the fleet of Magnox and Advanced Gas-cooled Reactors (AGR) power stations, and the PWR at Sizewell B. Other spent fuels have arisen from operations at Dounreay and research reactors and from nuclear submarine reactors. The arrangements for management of this spent fuel are described below.

B.14. Since the sixth UK NR, all of the remaining spent fuel has been removed from the Magnox reactors at Wylfa and Calder Hall, completing a programme of defueling over 55,000 teU of spent fuel across the UK Magnox reactor fleet. As of October 2019, all Magnox reactors were defueled and verified to be fuel free. All residual spent Magnox fuel, owned by the NDA, is now stored at Sellafield for final reprocessing in accordance with the MOP [8].

B.15. The MOP explicitly recognises the operational uncertainties associated with Magnox reprocessing, due primarily to the age of the facilities involved, which has led to some variation to throughput of fuel. To reflect this, the MOP considers upper and lower bound performance levels for throughput based on historic performance and commitments to improvement plans. The performance of plant and systems over this performance range has been underpinned to improve confidence in delivery of the overall programme.

B.16. As of May 2020, over 99% of the total spent Magnox fuel generated over the course of decades of Magnox reactor operations had been reprocessed, with less than around 600 teU remaining. This remaining material is expected to be reprocessed before the currently scheduled cessation of spent fuel reprocessing at Sellafield. Any residual spent fuel that has not been reprocessed by the time the reprocessing facility finally ceases operation will be safely and securely managed at Sellafield, pending a decision on treatment and packaging for disposal.

Spent Magnox Fuel and Magnox Operating Programme

B.17. Since the last NR, Calder Hall (four Magnox reactors) and Wylfa (two Magnox reactors) have been fully defueled. In September 2019, Magnox Limited dispatched the final flask of spent fuel from Wylfa to Sellafield (Figure 2), marking the end of defueling operations at all of the UK's first generation nuclear reactors. A 3 minute video of the final Magnox spent fuel arriving at Sellafield is available at the following link: www.youtube.com/watch?v=dCNxeCiM7pg.

Figure 3: Wylfa staff in front of the final flask of spent fuel from the site

B.18. This is a major milestone in the mission to safely decommission the Magnox sites and marks a very significant reduction in hazard and risk at the Wylfa site.

Spent AGR Fuels and the AGR Operating Programme

B.19. Similarly to the MOP, there is an AGR Operating Programme (AGROP), which provides a delivery programme for management of spent AGR fuel from the fleet of seven AGR power stations (each comprising of two reactors) operated by Électricité de France Nuclear Generation Ltd (EDF(NG)).

B.20. Following removal from the reactor and an initial period of cooling to reduce decay heat in dry buffer stores, the fuel is transferred to the station's cooling pond for a further period of at least 100 days. Subsequently, the spent fuel is transported to Sellafield for storage.

B.21. Over an extended period of around 24 years, THORP successfully fulfilled its contract to reprocess around 5020 te of AGR fuel. However, following the cessation of spent fuel reprocessing operations in THORP in November 2018, spent AGR fuel is now being stored in fuel ponds at Sellafield, pending a decision on its disposition.

B.22. The THORP Receipt and Storage Pond (TR&SP) was originally used for only short-term buffer storage prior to reprocessing. Following extensive regulatory engagement with Sellafield Ltd, ONR gave formal permission in 2018 to modify TR&SP to become an interim wet fuel storage facility for the long-term storage of AGR spent fuel. The modifications required were relatively straightforward, including a new dosing system to maintain pond water at an appropriate caustic pH and new storage racking to increase storage capacity. Additional cooling capability will be needed in the future (expected to be around 2023) given the higher heat loading as spent fuel accumulates.

B.23. TR&SP is expected to store all existing and future spent AGR fuel from the operating reactors, which could be up to 6,000 te. With appropriate control of pond water chemistry, AGR fuels are not expected to suffer any appreciable level of degradation during this interim storage period. As such, the interim wet storage of spent AGR fuel in the TR&SP is considered to meet the UK's strategic needs, with the fuel remaining in an acceptable condition up to the point of a final decision on its disposition.

B.24. In November 2018, THORP, on the Sellafield site, completed its 24-year mission to reprocess spent fuel. During this time, THORP reprocessed more than 9,000 te of fuel from 30 customers in nine countries around the world. End of reprocessing operations at THORP and finishing the overseas and domestic reprocessing contracts was a major milestone in the NDA's mission and an important move towards the end of all reprocessing at the Sellafield site, which will conclude with the closure of the Magnox Reprocessing Plant in 2020/21. The THORP facility will continue to serve the UK until the 2070s as a storage facility for spent fuel (Figure 3).

Figure 5: The Fuel Storage Ponds in THORP

Spent Pressurised Water Reactor Fuel

B.25. The UK has one operating PWR at the Sizewell B power station. The management of spent PWR fuel has not changed since the sixth UK NR.

B.26. All spent fuel generated at Sizewell B over its operational lifecycle phase, estimated to be 1,049 teU, is initially stored in the Fuel Storage Pond then transferred to the on-site purpose built Dry Fuel Store, until it can be dispatched for final disposal in a GDF when one becomes available. This is also the approach that will be taken with the Hinkley Point C power station which is currently being constructed.

Consolidation of other fuel materials at Sellafield

B.27. In addition to the large quantities of spent Magnox and AGR fuel, the NDA inventory of spent fuels also includes smaller quantities of non-standard and diverse fuel types, which were mostly created during early nuclear industry activities such as the development of research, experimental and prototype fuels and reactors in the 1960-70s. These are collectively referred to as 'exotic fuels', and include fuels from reactors at Dounreay, Winfrith, Imperial College (CONSORT research reactor) and from reactors used to power naval submarines.

B.28. The NDA strategy for managing 'exotic fuels' is to consolidate them at Sellafield [9]. This approach provides a number of significant benefits. Managing this material at Sellafield maximises the opportunity to use existing facilities and capability at Sellafield, and to build upon the existing technical expertise in managing nuclear materials. It also achieves significant hazard and risk reduction at the donor sites, enabling decommissioning to proceed more efficiently.

B.29. Some of these exotic fuels can be managed with bulk Magnox or AGR fuels where they are sufficiently similar. However, some present particular challenges which may require specifically tailored solutions for their long-term management and final disposition, such as encapsulation. As with spent Magnox and AGR fuel, after cessation of reprocessing, the exotic fuels will remain in interim storage at Sellafield, and if declared to be waste, will be dispatched for disposal at a GDF.

B.30. Details on the work undertaken to deal with Dounreay's exotic fuel are provided below.

B.31. At Dounreay, the first 11 teU of "breeder" fuel was removed from the DFR after its closure in 1977 and stored at the site. In 2011, after consulting the public on potential options, the decision was taken by the NDA to remove it from Dounreay. In December 2012, the first phase of 32 shipments left the site by road and rail. The final shipment arrived in Sellafield in June 2015, where it has been reprocessed. Extensive inspections and assessments carried out before, during, and after each move confirmed the transport was conducted without incident and in compliance with safety, security and transport regulations.

B.32. Phase 2 involves removing the remaining 992 stuck fuel elements (33 teU) from the reactor. A short video showing material being removed from the reactor core is available at the following link: www.youtube.com/watch?v=JCcq3X1XyXw. The elements are transferred to a separate facility where the clad is removed and the uranium and clad are treated to remove any alkali metal. This process began in 2017 and continues into 2020 with approximately 11 teU of the remaining 33 teU already shipped to Sellafield and reprocessed (therefore around 50% of all the breeder fuel that was in the reactor has been shipped to Sellafield). DFR fuel reprocessing will continue until the closure of Magnox reprocessing at Sellafield. After which the remaining DFR fuel will be safely managed at Sellafield following its removal from the Dounreay site.

B.33. The remainder of the Dounreay irradiated exotics (11 te), which includes the fuel from the final core of thePrototype Fast Reactor (PFR), are being safely managed at Dounreay, prior to transport to Sellafield.

Management of Overseas Origin Fuels Held in the UK

B.34. The NDA now owns title to a small amount of spent fuel of overseas origin (i.e. spent fuel from overseas customers that was not burned in UK reactors). This fuel was originally destined for reprocessing at THORP, but some of these fuels turned out to be not compatible or economic to reprocess at THORP. Following the commitment made in the NDA's strategy 3 [9], the NDA took the approach approved by UK government to subject these overseas origin fuels to 'virtual reprocessing'. This means that they are retained in the UK, NDA takes the title to them and that products and wastes are allocated to customers as if reprocessing had been carried out, and where appropriate, returned to customers in line with contractual commitments. This ensured that the UK did not become a net importer of nuclear waste. As a result, all spent fuel that is now committed to interim-term storage is UK owned and we no longer manage overseas owned fuels.

Management of nuclear material

B.35. The large-scale reprocessing of spent fuel from both UK Magnox and AGR power stations, but also from overseas energy utilities under historical commercial agreements, at Sellafield has generated significant inventories of separated plutonium and uranium. These materials are not currently declared as radioactive wastes. The management of these nuclear materials is described below.

Plutonium

B.36. On completion of spent fuel reprocessing operations and following transfer of all plutonium from Dounreay (completed by December 2019), there will be around 140 tonnes of civil separated plutonium stored at Sellafield, the largest single inventory in the world. The safe and secure management of this civil separated plutonium is a UK government priority.

B.37. The management and, ultimately, disposition of this plutonium inventory is considered to be one of the NDA's most complex challenges. The NDA and Sellafield Ltd are ensuring the continued safe and secure storage of plutonium by repacking the material for placement in a suite of modern stores. However, it is recognised that continued, indefinite, long-term storage leaves a burden of security risks and proliferation sensitivities for future generations to manage, and so disposition solutions are being considered.

B.38. In March 2019, the NDA published a report on Progress on plutonium consolidation, storage and disposition [10] which provides an update on developing and implementing the UK's plutonium management strategy in line with UK government policy. In summary, the disposition options being considered are:

- Reuse of the bulk plutonium inventory by conversion into mixed oxide fuel (MOX) (a blend of plutonium and uranium oxides) followed by disposal; and
- Creation of an immobilised product for storage, pending disposal in a GDF. Various methods of creating an immobilised product are being considered, including hot isostatic pressing (HIP), a pressing and sintering process, and encapsulation in a cement-based matrix.

B.39. UK government will only commit to implementation of a disposition programme once it has confidence that the preferred option can be implemented safely and securely, is affordable and offers value for money. At the moment, there is insufficient understanding for each option to move confidently to implementation. Further work is required to enable UK government to make a decision and establish a timeframe for a decision to be taken. The NDA is working with government on an agreed multi-year phase of work to develop the necessary level of technical understanding and maturity to inform a decision. This work is also informed by the considerations of ONR and the Environment Agency (EA), helping to identify any potential regulatory issues or concerns such that they are taken into account early on in support of the development of a viable solution.

Uranium

B.40. The NDA and other organisations own a range of diverse materials containing uranium, collectively termed 'uranics', arising from historic or current nuclear fuel cycle operations. The inventory includes uranium of various enrichments in oxide form, hexafluoride form and other forms.

B.41. The uranics inventory is currently stored safely and securely on a number of sites (including at Sellafield, Capenhurst and Springfields). The credible management options for uranics are:

- Continued safe and secure long-term storage, including any necessary conditioning to make the material suitable (such as de-conversion of uranium hexafluoride to an oxide form);
- Sale to a third party for recycling and reuse, where the material has commercial value; and
- Disposal in a GDF or other disposition option, including any necessary conditioning to make the material suitable. RWM will consider the feasibility of disposal of bulk uranics in a GDF in due course.

B.42. Given the diversity of types of uranics, it is expected that more than one of these options will need to be used to manage the whole inventory.

B.43. The Tails Management Facility (TMF) has been constructed by Urenco to provide the capability to convert uranium hexafluoride into a form suitable for long-term storage.

URENCO Tails Management Facility at Capenhurst

B.44. The TMF is to be operated by Urenco ChemPlants (UCP) as a tenant on the Urenco UK site at Capenhurst. It will de-convert depleted uranium in the form of uranium hexafluoride (UF_6), known as 'Tails', to triuranium octoxide (U_3O_8) and hydrofluoric acid (HF). U_3O_8 has the potential to be reconverted to UF_6 for enrichment in the future.

B.45. The TMF comprises six interconnecting facilities to receive full cylinders of Tails, de-convert them, store the resulting oxide, wash and retest the empty cylinders and decontaminate and treat the solid and liquid arising. The heart of the process is the de-conversion plant which has three functional units :

- *Vaporisation*: serves to heat and vaporise the solid Tails that is stored in Type 48Y transport cylinders into a gas that is fed to the de-conversion kilns.
- *De-conversion and Oxide Processing*: uses a UF_6 de-fluorination process, based on that deployed since the mid-1980s by Orano at a plant in France, which has successfully de-converted more than 300,000 Te of Tails. Following de-conversion, the oxide powder will be compacted and packaged into DV70 containers for long-term storage, pending its future re-use or disposal.
- *HF Processing and Storage*: will receive hydrofluoric acid from de-conversion, which is then processed and stored prior to its transfer into a road tanker for commercial use.

B.46. The Residue Recovery Facility will receive and treat solid and liquid arising from TMF operations through separating out recyclable material and immobilising or conditioning small quantities of other materials for disposal.

B.47. Officially opened in June 2019 following several years of construction, parts of TMF are now undergoing or have completed active commissioning. The Uranium Oxide Store and much of the TMF infrastructure is undergoing operational trials. The de-conversion plant is soon to enter its active commissioning stage subject to agreement from ONR.

B.48. At its busiest during construction there were approximately 2,100 workers on the TMF site, and in total 7,500 contractor staff underwent induction training through construction. At the time of writing approximately 7.3 million hours had been worked without an injury leading to time away from work.

B.49. The TMF facility has been developed primarily to improve safety. The de-conversion of legacy uranium material into a more chemically stable form will significantly improve the safety of this material during long-term storage. It will also enable the recycling of HF and the legacy cylinders.

B.50. In May 2019 it was announced that around 700 kg of highly enriched uranium (HEU) had been transferred in six individual shipments from Dounreay to the United States (US), where it will be down-blended for use in civil nuclear reactors [11]. In return, the US government provided an equivalent amount of material suitable for use in research reactors and, importantly, for the production of medical isotopes in Europe. The HEU was taken from the UK’s past experimental power reactor programmes.

B.51. This was the largest consignment of civil enriched uranium known to have been carried out. It required much technical and logistical preparatory work, involving many hundreds of hours of collaborative working between several UK and US organisations, to plan the consignments to ensure they were carried out safely and securely whilst meeting very challenging timescales.

B.52. In order to facilitate this the UK had to amend its Nuclear Security Regulations to enable it to regulate the transport of fissile material by air. Subsequently, the ONR and the US Department of Transport issued transport safety validations and approvals for the two transport packages used in accordance with the legal requirements for each country. In addition, necessary infrastructure work was undertaken. This included enlarging the runway at the local Wick John O’Groats airport to accommodate the US Air Force’s transport aircraft. Furthermore, in order to treat and package the material for transport Dounreay Site Restoration Ltd (DSRL) designed and installed a new uranium processing line and modified an existing glovebox system.

B.53. The US and UK organisations held detailed planning meetings and exercises to develop safety and security arrangements for the shipments, and lessons learned from each shipment were reviewed to refine the planning and contingency arrangements.

B.54. The transfer of this HEU from Dounreay to the US was an important milestone in the programme to decommission and clean-up the Dounreay site.

Radioactive Waste Management Policies and strategies (Article 32.1 (iii))

B.55. An overview of radioactive waste policies and strategies is provided below (Figure 4). These have not changed substantially since the previous NR. However, as mentioned above in paragraph B.2, the government has initiated work to update and consolidate its policy framework for nuclear decommissioning and radioactive substances.

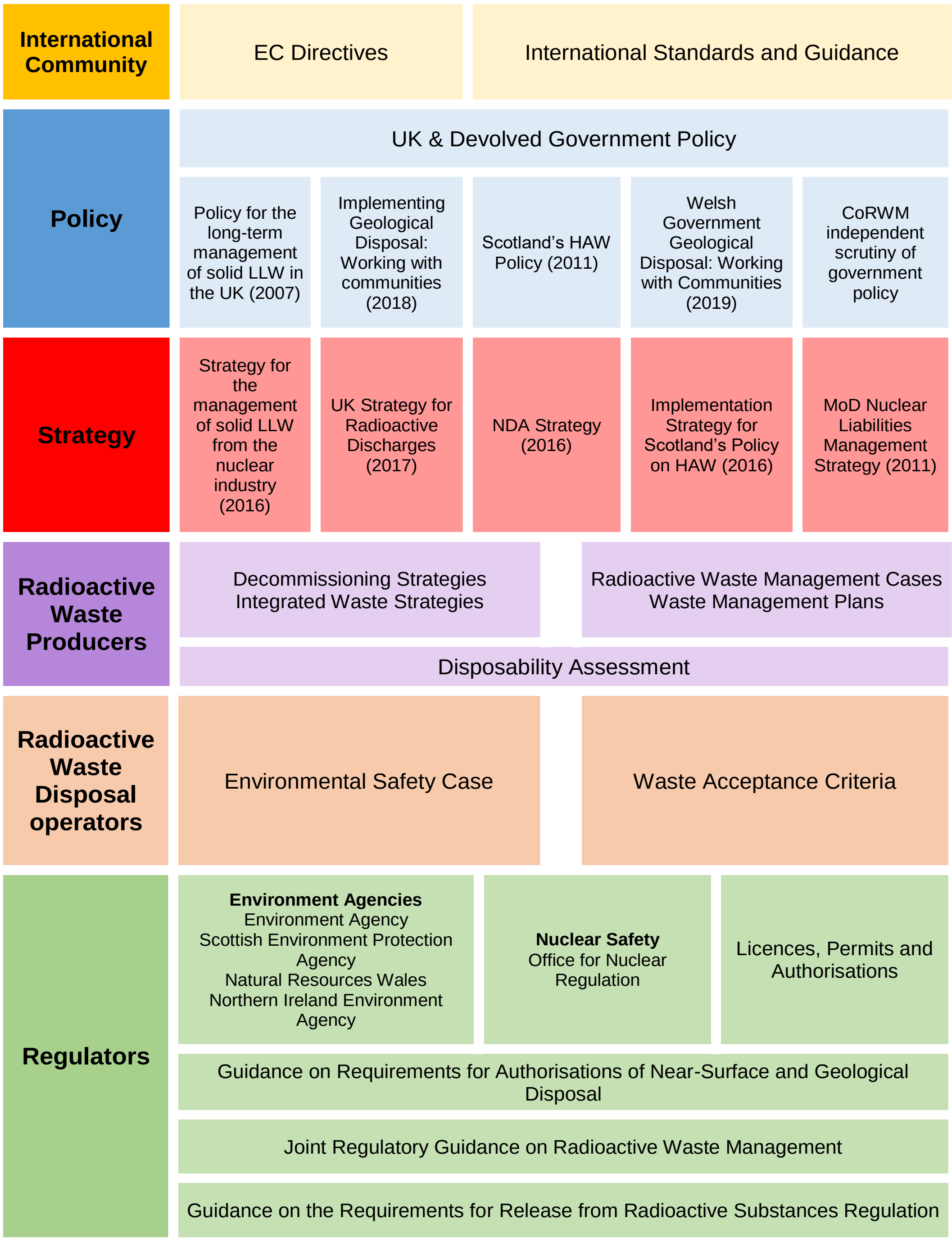


Figure 8: Waste management policy framework and regulatory bodies involved

General Radioactive Waste Management Policy

B.56. As described in Section E – Legislative and Regulatory System, radioactive waste management is a policy area that is devolved. The UK and devolved government's policies [5] for the management of radioactive wastes have the same basic principles as apply more generally to environmental policy and, in particular, sustainable development. More specifically, radioactive wastes should be managed in a manner that protects the public, workforce and environment.

B.57. Within this approach, the UK government continues to develop further policies and a regulatory framework which ensure that:

- radioactive wastes are not unnecessarily created, in accordance with the waste management hierarchy;
- the radioactive wastes that are created are safely and appropriately managed; and
- treated radioactive wastes are safely disposed of at appropriate times in appropriate ways.

B.58. Within that framework, the producers and owners of radioactive waste are responsible for ensuring that:

- they do not create waste and have no credible means to manage and/or dispose of it appropriately;
- waste should be made passively safe at the earliest opportunity;
- waste is characterised and segregated where appropriate to enable it to be managed optimally; and
- they undertake strategic planning, including the development of programmes for the disposal of waste accumulated at their sites within an appropriate timescale, including wastes from the decommissioning of redundant plants and facilities.

B.59. The producers and owners of radioactive waste in the UK are responsible for bearing the cost of managing and disposing of the wastes their activities generate.

Policy and strategy for the management of Higher-Activity Waste (HAW)

B.60. As described in Section E – Legislative and Regulatory System, the management of radioactive waste is a devolved issue. The policy for management of HAW is set separately for England, Wales and Scotland; (Northern Ireland does not have its own HAW policy). The relevant policies and strategies are described below.

Policy on HAW in England

B.61. In December 2018, the UK Government launched a new process to identify a suitable location for a GDF. It is a consent-based approach which requires a willing community to be a partner in the project's development. *Implementing Geological Disposal - Working with Communities. An updated framework for the long-term management of higher activity radioactive waste* [7] sets out the UK government's policy on managing HAW through implementing geological disposal. This document replaces the 2014 White Paper*, Implementing Geological Disposal*, in England.

B.62. The key features of the siting process are:

- A consent-based approach which requires a willing community to be a partner in the project's development;
- Early investment is provided to communities engaged in the process (up to £1 million annually rising up to £2.5 million);
- Before a decision is made to seek development consent, there must be a Test of Public Support by the community to demonstrate it is willing to host a GDF;
- Communities can leave the process at any time up until the Test of Public Support.

B.63. The UK government and regulators agree that the purpose of a GDF is to dispose of waste, not to store it. Therefore, waste emplaced within a GDF is not intended to be retrieved, although it is accepted that waste could potentially be retrieved if there were a compelling reason to do so. Based on the predicted inventory of waste to be consigned to the GDF, RWM estimate that the GDF could be in an operational state concurrently with on-going construction activity, receiving wastes for emplacement, for around one hundred years. Once operations cease, the GDF will be permanently closed at the earliest opportunity to achieve the benefits of greater safety and security and to minimise the burden on future generations.

B.64. The UK policy for the long-term management of HAW recognises that it is appropriate to investigate alternative options to a GDF for the long-term management of some of the UK's inventory of HAW. The NDA is required to review such alternative options. In support of this requirement and Scottish Government's HAW Policy, the NDA is exploring in more detail alternative management options for waste at the intermediate level and low level waste boundary, including opportunities for HAW disposal in near-surface facilities. The Government will consider the NDA's findings once its work is complete and will assess the implications for the government's policy on management of HAW. However, it is clear that in any realistic future scenario, some form of GDF will remain necessary.

Policy on HAW in Wales

B.65. Welsh Government policy on HAW [12] is broadly the same as that of the UK government. The policy is to adopt geological disposal for the long-term management of HAW.

B.66. The Welsh Government published a policy 'Geological disposal of higher activity radioactive waste: Working with communities' [13] in 2019, which requires appropriate engagement with communities which may wish to enter discussions, without prior commitment, about potentially hosting a GDF. The policy is clear that a GDF can only be built in Wales if a community is willing to host it.

B.67. This policy complements the UK government's Working with Communities policy but there are important differences such as administrative boundaries, the devolved planning system and the need to take account of the Welsh language.

Working with communities to site a GDF

B.68. Finding a suitable location for a GDF is a process that will take many years. The UK and Welsh Government have separate but compatible policies, both of which seek to find a community that is willing to host a GDF. Both the UK government [7] and Welsh Government [13] have therefore put in place policy frameworks to work in partnership with communities to build trust and understanding before any commitment is required.

B.69. A successful consent-based process needs a willing community with local authority support. The process itself must be open, transparent, flexible and democratically accountable.

B.70. Discussions about a proposed location for a GDF can be initiated by anyone or any group of people who wish to propose an area to RWM for consideration. The interested party may suggest an area of any size.

B.71. Once RWM and the interested party have had an initial exchange of information and agree that the proposal merits further consideration, they must jointly inform all relevant local authorities and open up discussions more widely in the community. This stage of the process is referred to as forming a Working Group.

B.72. A Working Group is established to engage with people in the area, identify a Search Area, within which RWM could consider potential sites, and develop and form a Community Partnership. Establishing a Working Group or a Community Partnership does not commit anyone involved to hosting a GDF. A community can withdraw from the siting process at any time up until it has taken a Test of Public Support.

B.73. In England, a Community Partnership must include at least one relevant Principal Local Authority and RWM. In Wales, a Local Authority must agree to be on the Community Partnership for land within its boundaries to be in the Search Area. An early action of a Community Partnership will be to sign an agreement setting out the principles of how the members of the Community Partnership will work together, their roles and responsibilities and how decisions could be taken including establishing relevant subgroups. It is within the Community Partnership phase of the siting process where site investigations take place and community investments are made. A Community Partnership is viewed as the enduring vehicle through which siting decisions are considered and progressed.

B.74. Increasingly detailed investigations will be carried out over a number of years. If there appears to be sufficient promise and there is continuing interest from the community then deep investigative boreholes will be drilled to test the geological conditions at depth. In order to carry out deep borehole investigations, RWM will need to gain the necessary planning permissions from the relevant authority and permits from the independent environmental regulators.

B.75. Detailed site investigations may take up to 15 years depending on the investigations necessary to understand the geology and be confident that a facility can be designed to isolate and contain radioactive waste safely and securely. When RWM has sufficient information to satisfy itself that a GDF is viable and the community has indicated it is willing to host it, RWM will need to obtain planning consent to build a GDF.

B.76. Before RWM seeks regulatory approval and planning permission to site a GDF in a particular community, there must be a Test of Public Support to determine whether the community is willing to host the facility. A GDF will also require Environmental Permits from the independent environmental regulators and a nuclear site licence from the ONR.

B.77. Figure 5 below illustrates the consent-based process for working with communities.

Figure 10: The consent-based process for working with communities to establish a GDF in England or Wales

Policy on HAW in Scotland

B.78. The Scottish Government does not support the GDF project but remains committed to the responsible management of the radioactive wastes arising in Scotland.

B.79. The Scottish Government published its own policy on the long-term management of HAW in January 2011 [14], based on near-site near-surface management of HAW in Scotland. The policy excludes HLW as HLW is not accumulated in Scotland and spent fuel and other nuclear materials not presently classified as waste are transferred to Sellafield.

B.80. The HAW policy includes the following key points:

- long-term management of HAW should take place in near-surface facilities;
- these facilities should be located as near as possible to the site where the waste was produced (the proximity principle); and
- developers will need to demonstrate how the facilities will be monitored and how waste packages, or waste, could be retrieved.

B.81. An implementation strategy [15] to support and expand on the framework set out in the HAW policy was published in 2016.

NDA Integrated Waste Management: Radioactive Waste Strategy

B.82. The delivery of the NDA mission to decommission and remediate the civil nuclear estate is dependent upon effective and optimised waste management, supported by a waste management infrastructure that is sustainable. To support this mission, in September 2019, the NDA published a single Radioactive Waste Strategy [16] that applies to all radioactive waste generated within the NDA estate (including materials that may become waste at some point in the future). It articulates the NDA's strategic positions and preferences, focussing on the following stages: planning and preparation, treatment and packaging, storage, and disposal. This single radioactive waste strategy replaced the previous NDA strategy for HAW and is consistent with the UK strategy for solid LLW, providing a consolidated position and greater clarity about the NDA's overall approach.

B.83. The strategy aims to optimise waste management and ensure that sustainable, effective and efficient management solutions are available at the right time, making best use of existing infrastructure and the development of new solutions when required. The strategy provides a high-level framework for flexible decision-making, to ensure safe, environmentally acceptable and cost-effective solutions that reflect the nature of the radioactive waste concerned. Specific benefits to come from implementation of the strategy include:

- Greater integration and optimisation;
- Embedding the application of the waste management hierarchy across the estate;
- A more proportionate risk-informed approach to managing wastes according to their nature (radiological, physical and chemical), rather than solely the radioactive waste category they fall into;
- Reduced costs over the full lifecycle; and
- Making best use of existing infrastructure and the development of new solutions when required.

B.84. An integrated programme has been developed to implement the NDA's strategy and drive changes in behaviour and culture to allow waste producers greater flexibility in managing their radioactive waste effectively, as well as developing proportionate solutions. This integrated programme will build on the success of the existing national LLW programme, which has significantly increased levels of reuse and recycling, while extending the life of the LLWR.

B.85. In July 2019 the NDA also published its first Mission Progress Report [17]. The report focuses on the four main themes that are outlined in the NDA's Strategy that are common across all the NDA sites and enables them to measure their achievements in relation to site decommissioning and remediation, integrated waste management, spent fuels and nuclear materials management.

Policy and strategy for the management of Low-Level radioactive Waste (LLW)

B.86. The policy and strategies for the management of LLW are the same in England, Wales, Scotland and Northern Ireland.

Policy for LLW

B.87. The UK government and devolved administrations published the policy for long-term management of solid LLW [18] in 2007. The policy remains unchanged and covers all aspects of the generation, management and regulation of solid LLW.

B.88. The policy provides a high-level framework within which individual LLW management decisions can be taken flexibly to ensure safe, environmentally-acceptable and cost-effective management solutions that appropriately reflect the nature of the LLW concerned. Given the wide range of LLW types and levels of radioactivity, the policy does not aim to be prescriptive in its approach. It introduced a risk-informed approach to determine the most appropriate disposal option for LLW, enabling waste managers to develop optimal solutions on a case by case basis. The overall aim of the policy was to provide greater flexibility in managing LLW, to facilitate managing waste from large scale decommissioning and environmental restoration work across the nuclear estate, as well as from other sources of LLW, and make best use of LLW disposal capacity at the LLWR.

B.89. The policy outlined the following priorities for managing solid LLW:

- Managing LLW in accordance with the waste management hierarchy principles, to minimise the amount of LLW created and requiring disposal through avoiding generation and minimising the amount of radioactive material used, as well as seeking to recycle and reuse, before, finally, looking at disposal options;
- Use of a risk-informed approach to ensure safety and protection of the public and the environment;
- Consideration of all practicable options for the management of LLW;
- Allowing greater flexibility in managing the wide range of LLW that already exists and will arise in the future; and
- Maintaining a focus on safety, with arrangements supported by the independent UK regulators.

Strategy for LLW

B.90. The UK-wide strategy for the management of solid low level radioactive waste from the nuclear industry [19] was last updated in 2016. It was developed by the NDA on behalf of the UK government and devolved administrations (i.e. the Welsh, Scottish and Northern Ireland administrations). The strategy is reviewed every five years to reflect significant changes which have occurred since the previous review and ensure it remains fit for purpose.

B.91. The three strategic themes for solid LLW are:

- Application of the waste management hierarchy;
- Best use of existing LLW management assets;
- The need for new fit for purpose waste management routes.

B.92. A key aim of the strategy is the continued development and maintenance of an efficient, sustainable waste management infrastructure, and a range of alternative LLW treatment and disposal routes. The strategy requires waste producers to manage their wastes in accordance with the waste management hierarchy and as part of a wider integrated framework for optimised waste management and use of the most appropriate routes. Implementation of the strategy has resulted in significant quantities of LLW being diverted from disposal to the LLWR.

B.93. The LLW National Waste Programme (NWP) was established to lead the implementation of the LLW strategy. LLWR Ltd manages the programme, on behalf of the NDA, and through collaboration with all the UK's nuclear LLW producers to ensure its effective implementation through a range of programmes and governance activities.

B.94. The Strategy for the management of solid low level radioactive waste from the non-nuclear industry in the UK [20] remains unchanged since 2012. The UK government together with the devolved administrations recognised that the management of radioactive wastes from most of the non-nuclear industry, particularly low volume VLLW, is linked with that of commercial and other industrial waste, with which it is largely treated. However, it recognised that the small volumes of LLW which are generated are insufficient to drive the provision of exclusive treatment/disposal facilities via the commercial market. Consequently, the strategy sought to ensure a better understanding of the types and quantities of wastes generated, and to see that existing disposal routes are conserved. In particular it encouraged careful consideration of spatial planning for waste management, and the expectations that the NDA will make provision within its supply chain arrangements for the disposal of non-nuclear LLW (provided that the provision does not compromise its primary mission).

B.95. The strategy for the management of Naturally Occurring Radioactive Material (NORM) waste in the UK [21] was developed and published jointly in 2014 by UK government and the devolved administrations.

Proposals to Exclude Disposal Sites for LLW and VLLW from the Requirements of the Paris & Brussels Convention

B.96. The UK is in the process of implementing changes to the Paris and Brussels Conventions on nuclear third-party liability (which governs the payment of compensation for damage caused by nuclear incidents) into UK law, in particular the Nuclear Installations Act 1965 (NIA65). The revised Paris Convention imposes a liability regime on installations for the disposal of nuclear substances, including landfill sites that accept LLW and VLLW, in their pre-closure and post-closure phases and requires insurance or other approved financial security to cover third-party liability.

B.97. The UK government considers this liability regime should not apply to such landfill facilities, on the basis that those sites do not present a sufficient level of risk to warrant compliance with the requirements of the Paris regime. The UK government therefore made proposals to the Organisation for Economic Co-operation and Development Nuclear Energy Agency (OECD NEA) Nuclear Law Committee, seeking exclusion under Article 1(b) of the Paris Convention from the special liability regime for this type of site. The OECD Steering Committee for Nuclear Energy adopted the exclusion decision and recommendation [22] in November 2016 which gives Contracting Parties the option to exclude such sites, provided certain criteria are met. We refer to this decision as the ‘Low Level Waste Exclusion’ (LLW Exclusion). Exclusion from the Paris regime would not affect the regulation of the landfill facilities and any person suffering damage as a result of an incident at such facilities would be able to claim compensation under ordinary civil law.

B.98. The Nuclear Installations (Prescribed Sites and Transport) Regulations 2018 propose changes to the nuclear liability regime in the UK that will define categories of low and intermediate risk nuclear sites and transport movements for which lower levels of liability will apply. The UK government has committed to introducing legislation to implement the LLW Exclusion.

Policy on the Decommissioning of the UK’s Nuclear Facilities

B.99. Government policy on the decommissioning of nuclear facilities is set out in the 2004 statement issued by the UK government and the devolved administrations [23]. Key points of the policy are noted below. The policy covers the decommissioning of all existing and new UK nuclear industry facilities, including power stations and other nuclear reactors, research facilities, fuel fabrication and reprocessing plants and laboratories on licensed nuclear sites. It also includes the site at Culham used for research into fusion, and where relevant, facilities on the Defence Nuclear Programme sites. The policy also covers, in England and Wales, the new build nuclear programme and Small Modular Reactors and Advanced Modular Reactors.

B.100. The objective of decommissioning is to progressively reduce the hazard that a redundant facility poses, with the ultimate aim of removing regulatory controls so that the facility and its site can potentially be reused for other purposes. Decommissioning includes activities such as planning, physical and radiological characterisation, decontamination, land remediation and management of resultant non-radioactive and radioactive wastes arising from the decommissioning activities. Decommissioning is expected to start as soon as is reasonably practicable after the facility has ceased operations unless there are demonstrable benefits to deferring it.

B.101. The policy does not prescribe how decommissioning should be undertaken. It acknowledges that the responsibility for decommissioning lies with the operator and decisions on how to decommission a facility and the nature of the end-state for the site must be determined on a case by case basis. Relevant factors to take into account are ensuring worker and public safety, minimising waste generation, managing ageing infrastructure over the period of decommissioning and effectively managing wastes which are created. Adequate funding for the decommissioning of a facility must be provided.

B.102. The policy recognises that decommissioning can involve separate stages spanning a number of decades, for instance to take advantage of radioactive decay and reduce worker dose during dismantling activities, or to benefit from new or developing technologies (such as remote operations). This deferred decommissioning approach has been used for the Bradwell site, where following some initial decommissioning work, the site was put into an extended period of C&M until the final site clearance phase begins in several decades time. The decommissioning strategy to place all Magnox nuclear power stations into C&M for a number of decades before final site clearance has recently been reviewed in light of experience with Bradwell and more general reassessment of this approach. The NDA and Magnox Ltd have decided to move away from this blanket approach and to consider decommissioning some sites earlier than previously anticipated i.e. without entering into C&M. Some other UK nuclear facilities, such as those on the Dounreay, Harwell and Winfrith sites, are undergoing prompt decommissioning to a defined end-state.

B.103. Each operator is required to produce and maintain a decommissioning strategy and plans for its sites, developed taking into account views from stakeholders (including relevant local authorities and the public). A decommissioning strategy may apply to more than one site, such as similar sites within the NDA estate; the site specific plans should be consistent with the overall strategy. The decommissioning strategy and plans are required to be kept under review, typically carried out on a 5-yearly basis.

B.104. Decommissioning is considered to be a discrete stage in a facility's lifecycle, and therefore remains under full regulatory control throughout, until the site is removed from regulatory control. The nuclear site licence requires the operator to make and implement adequate arrangements for the decommissioning of any plant or process which may affect safety. This should include a comprehensive site decommissioning plan for carrying out the decommissioning process with due regard for safety, security and environmental protection. Operators are expected to take into account features that could both facilitate and reduce the costs and timescales of decommissioning during the design, operation and post-operations clean-out (POCO) of facilities. For instance, the regulatory Generic Design Assessment (GDA) for new nuclear power stations [24] includes explicit consideration of how the power station will be decommissioned at the end of its operational life. Additionally, at Sellafield, the POCO of various facilities, such as THORP, is aiming to remove as much contaminated material as possible to facilitate efficient and effective decommissioning of the facility.

B.105. Some decommissioning activities, especially in the early stages, may necessarily introduce a short-term increase in risk to safety or increased radioactive discharges to the environment, in order to achieve reduction in overall risk, for example when making modifications to legacy facilities and working in ageing and degraded structures. This may be unavoidable in order to progress the work, but the associated risks must always be reduced so far as is reasonably practicable (SFAIRP) and the approach must be compliant with legal requirements.

B.106. The goal-setting nature of the UK regulatory system enables a flexible and proportionate approach to be taken. The operator can determine the most appropriate means to carry out decommissioning safely and effectively, often using innovative approaches to deal with the unique problems encountered in decommissioning.

Radioactive Waste Management Practices (Article 32.1(iv))

B.107. The routine practices for management of LLW, ILW and HLW, summarised below, have not changed significantly since the sixth UK NR. These practices continue to develop and improve to meet the challenges posed, in particular in managing the significant amount of waste arising from operational sites and decommissioning activities across the NDA estate. There has been a general strengthening of the radioactive waste management infrastructure and diversification of the waste routes available through the supply chain, providing waste producers with greater flexibility in managing their radioactive waste effectively.

B.108. To illustrate how the these practices contribute to the on-going effectiveness and safety of radioactive waste management across the UK nuclear industry, experience is presented below in relation to some general high level themes: optimising waste management; management of legacy facilities and wastes; knowledge / information management; and innovation.

Practices relating to the management of Low-Level radioactive Waste

B.109. The UK Radioactive Waste Inventory (UKRWI) [25] details the current estimates of radioactive wastes arising in the UK from major waste producers, i.e. the nuclear industry. It does not include the current or expected waste arising from the non-nuclear producers of waste and nor does it include estimates of NORM waste arising [26]. Approximately 95% of the total volume of the UK's reported waste inventory comprises LLW, including VLLW, amounting to ~ 4.3 million m^3.

B.110. The 2019 UKRWI [27] indicated that at 1 April 2019 the volume of un-disposed LLW accumulated across the UK in the nuclear industry was about 27,400 m^3 (of which 15,700 m^3 was at Dounreay). The majority of this is in temporary storage pending either recycling or disposal. A small fraction of LLW is unsuitable for consignment to the LLWR or disposal to landfill because the wastes do not meet the relevant waste acceptance criteria at these sites. These criteria incorporate limits on non-radiological chemical and physical properties in addition to radiological properties. Some of these wastes are oils that may be incinerated. Some will require the development of new treatment techniques in order to meet the LLWR acceptance criteria. As a last resort such wastes will need to be managed as if it was HAW.

B.111. The strategies for management of LLW (described above) address the challenge that managing this amount of LLW presents for the UK. The strategies each provide a high-level framework which guides decision makers for radioactive waste management to work flexibly to ensure safe, environmentally acceptable and cost-effective management solutions. Central to each of the strategies is the implementation of the waste management hierarchy in the management of wastes, the best use of existing waste management assets, and development of new fit-for-purpose waste management routes.

B.112. The UK government has encouraged all those who have the potential to generate radioactive wastes to consider first the ways in which radioactive waste generation can be avoided. For example, in seeking more efficient design of new nuclear reactors, and making best use of characterisation techniques to avoid unnecessary categorisation of wastes as radioactive. Radioactive waste that is generated must then be minimised where practicable through consideration of a broader range of options including reuse and recycling, before settling on the final option of disposal. The revised LLW policy and subsequent strategies for the management of LLW, have contributed to a range of treatment and disposal options now being available to radioactive waste producers in the UK, primarily within the supply chain.

Low Level radioactive Waste Repository Ltd disposal and waste management services

B.113. The UK's only national radioactive waste disposal facility for LLW is the LLWR (operated by LLWR Ltd). At LLWR the waste is encapsulated within ISO containers which are placed in engineered concrete-lined near-surface vaults. On 1 April 2019, the ISO containers occupied approximately 233,000 m^3 of vault space.

B.114. Since the previous UK NR, more efficient LLW management practices have continued to be developed to enable a more sustainable approach to the management of radioactive wastes from both the nuclear and non-nuclear industries, including the most effective use of the LLWR. This includes the continued application of the waste management hierarchy and use of treatment routes, such as metal recycling and thermal treatment, as well as the diversion of LLW to other more suitable routes for disposal (such as permitted landfills). The continued success of the NWP has helped incentivise further commercial investment into radioactive waste solutions within the UK which, in turn, helps sustain operators' access to a reliable radioactive waste infrastructure.

B.115. The 2016 UK nuclear LLW strategy is implemented through the NWP managed by LLWR Ltd, which brings together waste producers, treatment and disposal providers and the regulators, to enable sharing of relevant good practice and learning. Separately, LLWR Ltd also provides waste producers with access to a broad range of waste management services either directly or through the supply chain via framework agreements which include:

- metallic waste treatment;
- combustible waste treatment;
- super-compaction;
- solid radioactive waste disposal to permitted landfills;
- packaging processes;
- waste characterisation service;
- transport service;
- alternate treatment service;
- expert support service; and
- solid radioactive disposal at the LLWR.

B.116. The provision of these services has continued to enable the diversion of approximately 98% of the LLW/VLLW arising away from the LLWR during 2019/20; this amounted to approximately 20,380 m^3 thereby preserving valuable disposal capacity. It has also been successfully used to manage problematic materials such as alpha contaminated oil.

B.117. Tradebe Inutec, based at its facility on the Winfrith nuclear site in Dorset, Southern England, offers a range of waste management services for metallic, super-compactible and combustible waste. It can also arrange trans frontier shipments of compatible metallic wastes for treatment at the smelter at Siempelkamp in Germany and the Energy Solutions Bear Creek facility in the United States of America (USA).

B.118. In February 2019, a new nuclear site licence and environmental permit was issued to Tradebe Inutec to support its further development of radioactive waste management facilities on the site.

Metal LLW Recycling

B.119. Through LLWR Ltd's commercial frameworks or direct contracts with other licensed nuclear sites and other radioactive waste producers, the Cyclife UK Ltd Metal Recycling Facility (MRF), in Lillyhall, West Cumbria, manages metallic LLW in accordance with the requirements of the waste management hierarchy, using size reduction and shot blasting to reduce the volume of waste and recover valuable metals. Cyclife also arranges trans-frontier shipments of metal wastes to its Swedish melting facility in Nyköping, Sweden.

B.120. The use of metal recycling has reduced the volume of metallic waste requiring disposal by around 31,215 m^3 since 2010.

Combustible LLW Treatment

B.121. Within the UK, incineration is a mature waste treatment technology and has been permitted for many years for treating suitable LLW. The process typically reduces waste volumes by up to 98% by burning combustible solid and liquid wastes, breaking down the reactive compounds and organics to create a stable homogeneous waste form (ash) for disposal.

B.122. Several commercial incinerators are presently permitted by the environment agencies and are available to the UK nuclear industry and other radioactive waste producers. These facilities have significant differences in the quantity, type of radioactivity and physical nature of the waste that they can accept. They are available to waste generators through LLWR Ltd’s commercial frameworks or by using direct contracts.

B.123. The use of incineration has reduced the volume of waste requiring disposal by around 24,570 m^3 since 2011.

Dounreay LLW Disposal Facility

B.124. The Dounreay LLW disposal facility (Figure 6), operated by DSRL, adjacent to the Dounreay licensed nuclear site, is another near-surface LLW disposal facility. It was authorised for use by the Scottish Environment Protection Agency (SEPA) in January 2013. It is used to dispose of LLW that arises from the Dounreay site and the adjacent Vulcan defence site which was previously used to test PWR reactors used to power naval submarines. At present only two vaults have been constructed, together with a grouting plant. The planning consent for the facility allows for construction of up to a further four vaults.

Figure 12: The Dounreay Low Level Waste Disposal Facility

Landfill disposal for lower activity radioactive wastes

B.125. The UK has several commercially available landfill sites which are permitted to receive and dispose of lower activity radioactive wastes from both the nuclear and non-nuclear industries. In England these are: the Lillyhall Landfill in Cumbria, the East Northants Resource Management Facility in Northamptonshire, the Clifton Marsh landfill in Lancashire; and in Scotland there is the Stoneyhill landfill in Aberdeenshire. There is also a landfill disposal site, Calder Landfill Extension Segregated Area (CLESA), on the Sellafield site.

B.126. A commercial landfill operator has recently applied for a permit for LLW disposal at an existing commercial hazardous waste landfill site at Port Clarence, in the North-East of England.

B.127. Overall, the extant commercial means of disposal of radioactive waste to landfill sites provides the UK with an additional waste disposal capacity of approximately 1 million m^3.

Practices relating to the management of Intermediate-Level radioactive Waste (ILW)

B.128. ILW arises from a range of facilities and activities in the UK, including reprocessing of spent fuel, operations and maintenance of nuclear power stations, and decommissioning. Additionally, there is also a significant inventory of ILW in legacy facilities which requires retrieval for transfer to safer storage pending disposal, particularly at Sellafield.

B.129. The majority of ILW being produced includes operational wastes, such as ion-exchange resins and filter media, and wastes typically produced during decommissioning, such as metals and organic materials, with smaller quantities of concrete, graphite, glass and ceramics. As more facilities enter the decommissioning phase, the quantities of metal, concrete and graphite wastes produced will increase significantly; it is expected that the vast majority of decommissioning wastes will be VLLW, LLW and ‘lower-end’ ILW, of much lower overall radiological content than legacy wastes. Sellafield holds the majority of the UK ILW inventory, with the remaining inventory generally at nuclear sites across the UK. As of 1 April 2019, the volume of ILW in the UK is 102,000 m^3.

B.130. ILW is stored safely, pending its future management in line with national policies (future disposal in a GDF in England or Wales, or management in near surface facilities in Scotland). In general, the expectation is that ILW is conditioned to a passively safe form for storage as soon as reasonably practicable. The RWM disposability assessment process provides assurance that waste packages containing conditioned ILW should be suitable for geological disposal.

Management of reactor core graphite

B.131. The UK has accumulated and will continue to amass a large quantity of irradiated graphite waste. The material comprises the bulk neutron moderator in the operating AGRs and in the shutdown Magnox reactor cores. There is approximately 60,000 te of graphite waste currently contained within the Magnox reactor pressure vessels alone. It is recognised that the graphite in AGR reactor cores will also need to be managed once these reactors are shut down.

B.132. The NDA's current strategy for management of graphite waste was described in the NDA's previous HAW Strategy [28] and the overall approach to waste management is outlined in its current Radioactive Waste Strategy [16]. The strategy was developed in the context of the baseline strategy for decommissioning Magnox reactors being deferred for a number of decades. In this case the bulk of graphite would not arise until 2070 onwards, at which time it would be conditioned into a form suitable for disposal in a GDF in England/Wales or for management in near-surface facilities in Scotland.

B.133. However, the NDA has determined that the blanket deferral of Magnox reactor decommissioning is not optimal and has decided to adopt site specific decommissioning strategies which would mean the decommissioning of some sites would be earlier than previously anticipated, which would create bulk graphite arising requiring management earlier than currently anticipated.

B.134. NDA and Magnox Ltd are actively working to develop alternative management options for managing bulk graphite waste and aligning this work with the timing and sequencing of the Magnox reactor dismantling programme as it develops.

RWM Disposability Assessment Process and Letters of Compliance (LoC)

B.135. RWM, as developer of the GDF, is recognised as the appropriate body to provide advice to nuclear site operators on the packaging and conditioning of HAW for geological disposal. This advice is provided through RWM's disposability assessment process.

B.136. RWM has developed a generic geological disposal system concept and an associated generic Disposal System Safety Case (gDSSC). The gDSSC documents the specification and requirements, design and safety case for a non-site specific disposal facility, to demonstrate that a GDF could be constructed in suitable geological environments and used for the safe disposal of HAW. It provides the safety justification for all phases of the lifecycle of a GDF – transportation of wastes to it, operation (including emplacement of HAW waste packages into vaults etc.) and its safety in the period, following GDF closure. The gDSSC [29] is updated periodically as the disposal concept develops; it was initially created in 2010 and was most recently updated in 2016. In November 2018, ONR and the EA published a Joint Regulators' Assessment of the 2016 gDSSC [30].

B.137. Based on the gDSSC, RWM has developed extensive documentation to support disposability assessment. The documentation is referred to as the Waste Package Specification and Guidance Documentation suite [31]. It includes a number of generic waste package specifications for packages that are compatible with disposal in a GDF that meets the design intent specified in the gDSSC. The suite of documents also includes guidance documentation to assist waste producers at a practical level in developing compliant conditioning and packaging plans. RWM are open to the assessment of new and innovative types of waste packages when they are proposed by operators. A recent example is Ductile Cast Iron Containers (DCICs).

B.138. The RWM disposability assessment process [32] consists of a series of technical evaluations and safety assessments of waste producers' proposals for conditioning and packaging of HAW. The assessment is documented in an Assessment Report. If RWM considers that the packaged waste is likely to be suitable for disposal in a future GDF a Letter of Compliance (LoC) is issued for that proposal.

B.139. The disposability assessment and issue of LoCs takes a staged approach, which enables operators to provide RWM with increasingly substantiated evidence supporting their plans to condition and package HAW as they develop technically and operationally. These stages are conceptual-, interim- and final-stage, which broadly align with the typical approach used to develop HAW management plans (Figure 7). In summary, the conceptual-stage LoCs support work on potential options to establish the feasibility of a packaging proposal; interim-stage LoCs establish if the 'as designed' waste packages will be disposable; and the final-stage LoCs are normally given following active commissioning of plant and demonstration that the 'as manufactured' waste packages will be disposable. All final stage LoCs (fLoCs) are subject to periodic review by RWM, typically every 10 years (although recently a more risk-informed review process is being applied), to ensure they remain compliant with the latest version of the gDSSC.

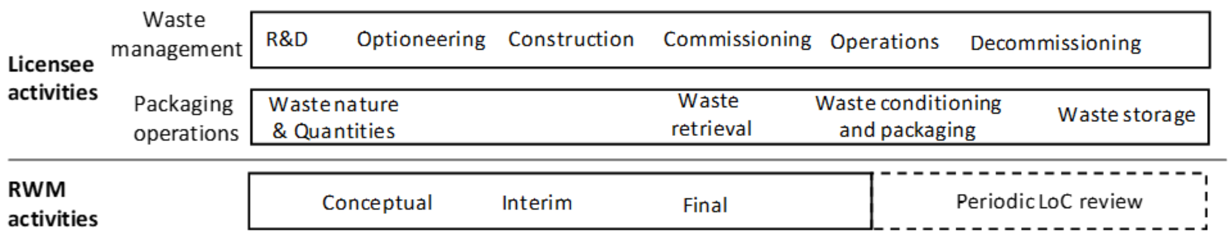


Figure 14: Staged endorsed LoCs and link to stages of HAW management

B.140. fLoCs include a requirement that adequate waste package records must be maintained. Such records hold all the information required to support future stages of the long-term management of the HAW, including the physical and chemical nature of the waste, waste package storage conditions, and inventory of radionuclides present etc. Operators are expected to have developed an adequate data recording system, evaluated in the disposability assessment process, to create and manage these records.

B.141. The RWM LoC process provides assurance that HAW waste packages will be suitable for disposal in a future GDF and that legacy wastes with no disposal route will not be created. Nuclear site operators are expected to obtain LoCs for their HAW packages as part of their waste management process.

B.142. A number of LoCs have been issued by RWM since the sixth UK NR in support of on-going operational and decommissioning activities. Final stage LoCs have been issued for the following:

- A range of wastes from Bradwell and other Magnox stations, such as cooling pond sludge and ion-exchange resin, packaged in DCICs;
- Hunterston A sludge and ion-exchange resin encapsulated in-drum with cementitious grout;
- Packaging of Magnox Fuel Element Debris (FED);
- Packaging of effluents in the Waste Processing and Encapsulation Plant (WPEP) at Sellafield;
- Packaging of PFSP wastes in the Waste Encapsulation Plant (WEP) at Sellafield;
- Packaging PFR Raffinate in cementitious grout in 500L drums at Dounreay

B.143. In addition, conceptual-stage and interim-stage LoCs and re-endorsements following Periodic Reviews have also been issued since the sixth UK NR.

B.144. As mentioned earlier, the Scottish Government HAW policy does not include geological disposal. However, regulators consider that waste packages conditioned in anticipation of geological disposal are also suitable for long-term management in near-surface facilities. On this basis, the RWM disposability assessment/LoC process is considered to provide an appropriate basis to support the safe storage of HAW in Scotland. This position is kept under review and was formally re-confirmed by ONR and SEPA in 2017 in a report of their Inspection of RWM's disposability assessment for the management of HAW in Scotland [33].

Radioactive Waste Management Cases

B.145. The regulators (ONR and the environment agencies) have produced joint guidance on The management of HAW on licensed nuclear sites [6]. This guidance presents what the regulators consider to be relevant good practice and a means to achieve compliance with legal requirements.

B.146. The joint guidance presents the regulatory expectations for Radioactive Waste Management Cases (RWMCs). RWMCs present a consolidated summary of how a particular waste stream or waste streams will be managed safely from generation through conditioning, storage and up to removal from site for eventual disposal. It is a top tier document, describing the waste management details, but with the more detailed substantiating and underpinning information provided in safety case justifications and other documentation.

B.147. The operator is free to decide the scope of individual RMWCs to cover either single waste streams or a group of waste streams. However, the regulatory expectation is that the operator develops one or more RWMCs which together cover all HAW being managed on the site.

Interim-storage of ILW

B.148. ILW accumulated on licensed nuclear sites is almost all placed in interim storage in suitable waste stores or is safely contained in structures yet to be dismantled (e.g. reactor core graphite), pending eventual disposal in a GDF in England or Wales or management in near surface facilities in Scotland. In general, the ILW is expected to be conditioned to a passively safe state, as soon as reasonably practicable, to maximise safety and reduce the need for on-going safety measures such as inspection and monitoring during the storage period. The NDA has produced industry guidance presenting good practice for the interim storage of HAW [34]. This was updated in January 2017. It is being further updated, with publication expected later in 2020, to explicitly include the interim storage of unconditioned waste which is not yet in a passively safe condition. This update to the guidance is particularly relevant to wastes being retrieved from Sellafield legacy silos (MSSS and PFCS). Due to the imperative to retrieve these wastes from legacy facilities, the wastes will be retrieved to safe storage, but conditioning to a passively safe form will take place at a later date.

Practices relating to the management of High-Level Waste

B.149. Highly Active Liquor (HAL) is heat-generating waste containing very high levels of fission products that has accumulated since the early 1950s at Sellafield as a by-product of reprocessing of spent fuel. HAL is concentrated and stored in highly engineered containment, within the Highly-Active Liquor Evaporation and Storage (HALES) plant, prior to undergoing a process of vitrification to make it physically stable. Vitrification involves the incorporation of HAL in liquid glass, which is poured into high-integrity stainless steel containers to undergo cooling and solidification. The vitrified HAL is then stored in environmentally controlled, safe and secure conditions, pending either return to the country of origin or eventual geological disposal. Current government policy is that the UK's vitrified HAL should be stored for at least 50 years to benefit from radioactive decay and to simplify its subsequent long-term management.

B.150. As of 1 April 2020, the current UK inventory of HAL is 2,150 m^3 (more information is presented in Section D - Inventories and Lists). Concerted work by ONR, NDA and Sellafield Ltd on the management of HAL has enabled a significant and sustained reduction in the HAL stocks to be achieved, with significant reductions in the associated hazard. As reprocessing finally comes to an end it is anticipated that the HAL stocks will continue to steadily reduce over the next decade. Figure 8 below shows the inventory reduction curve for HAL stocks from 2001 through to 2030.

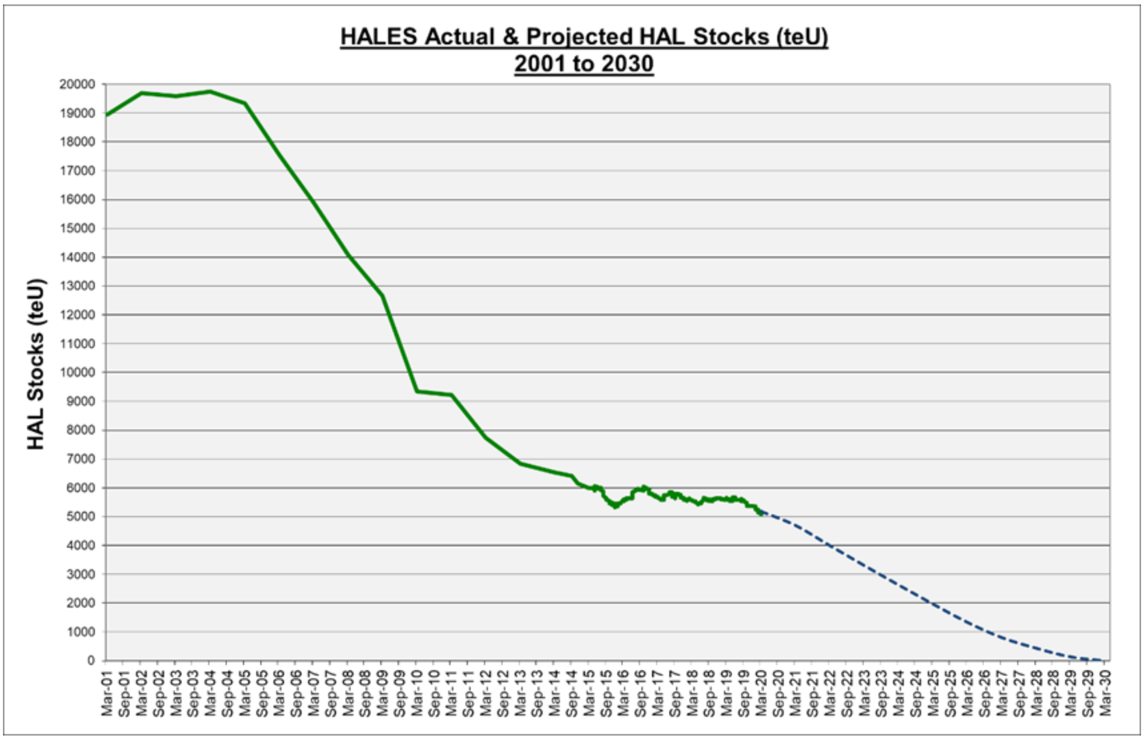


Figure 16: HALES Actual & Projected HAL Stocks (teU) 2001-2030

Optimising waste management and site clean-up

B.151. There is a strong drive within the UK waste management community to optimise waste management and provide for a sustainable waste management infrastructure that provides flexibility for efficient and cost-effective waste management solutions to be implemented.

B.152. The waste management policies and strategies all support such optimisation, developing diversity in management options. These are implemented in practice through various programmes, requirements and initiatives. Some examples of these are described in the case studies highlighted in the blue boxes below.

B.153. In 2018, the environment agencies published guidance entitled '*Management of radioactive waste from the decommissioning of nuclear sites: guidance on the requirements for release from radioactive substances regulation (RSR)*' (also known as GRR) [35]. This guidance explains the requirements the environment agencies expect nuclear site operators to fulfil when developing their plans for the management of radioactive waste from decommissioning and how implementing these plans will leave sites in a state suitable for release from radioactive substances regulation. Increased flexibility, together with a proportionate approach to managing residual risk, is achieved through application of the GRR, which will require that an optimised solution to protection of people and the environment is demonstrated through a Waste Management Plan (WMP) and a Site Wide Environmental Safety Case (SWESC).

B.154. The GRR was trialled through three 'lead and learn' NDA sites (Winfrith, Dounreay and Trawsfynydd) and lessons learnt from this were incorporated into the final regulatory guidance. Following publication of the guidance, the EA introduced new permit conditions for all nuclear site operators in England which require the development of both a WMP and a SWESC as described within the GRR. The environment agencies are currently working with industry to develop a national programme for the implementation of these requirements, involving the production of WMPs and SWESCs at every UK nuclear site. This collaborative approach to implementation is intended to help ensure that the implementation takes account of the fact that sites across the UK are at various stages of decommissioning and in order to help ensure that lessons continue to be learnt and shared across the industry.

B.155. A key feature of the guidance is the clarification that it provides in terms of the range of waste management opportunities that might be considered in developing an optimised approach to waste management and site release, including in-situ and other forms of on-site disposal (Figure 9).

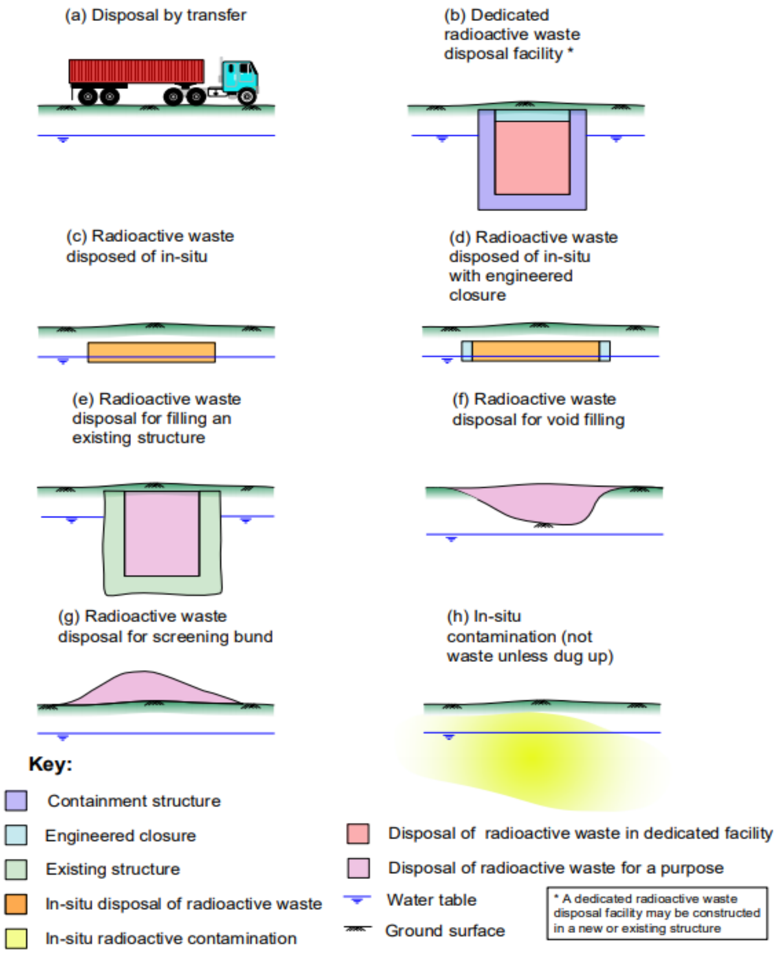


Figure 18: Potential management options for radioactive substances from the final stages of decommissioning of nuclear site

B.156. Adopting this approach to the optimisation of waste management and site clean-up is a key development. It seeks to ensure that nuclear site operators avoid the unnecessary creation of wastes and develop more sustainable approaches to radioactive waste management.

B.157. Since the sixth UK NR, there has been significant progress in developing integrated waste management practices. Integrated waste management optimises the management of waste over the full waste management lifecycle, by for instance promoting and sustaining the use of the waste management hierarchy, providing adequate capability for timely characterisation and segregation of waste, adopting flexibility in options being considered for disposal, and making best use of existing infrastructure (e.g. shared facilities).

B.158. NDA has developed a radioactive waste strategy [16] to optimise waste management across its estate. This will enable the NDA to promote opportunities to embed the use of the waste management hierarchy and sharing treatment and storage assets. For example, regionalised consolidation of ILW is being used, where a single ILW store is used to store ILW arising from other sites in the same geographical region, thereby maximising use of that facility and reducing safety and security burdens on the donor sites. This type of approach has been progressed through engagement and agreement with all relevant stakeholders, including the regulators, local authorities and populace.

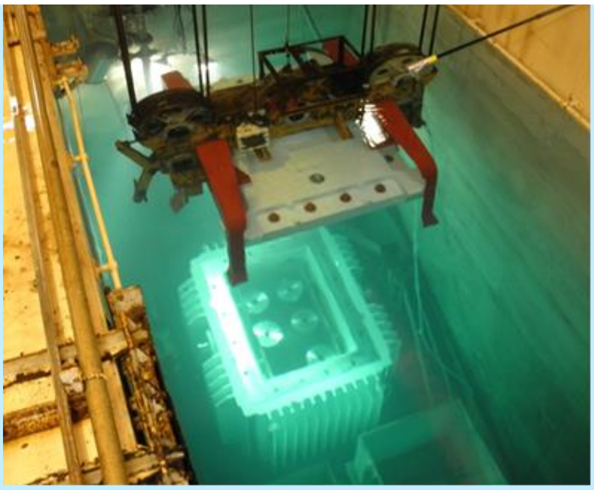
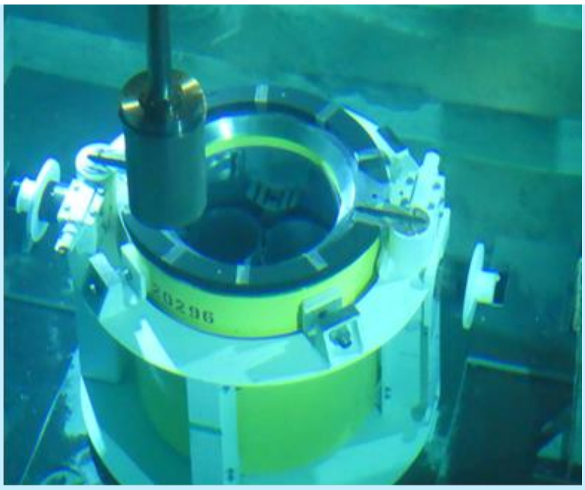
Increasing cost efficiency and improving safety through consolidated waste operations at Magnox Ltd

B.159. Magnox Ltd. is making use of shared facilities, where appropriate, by transporting ILW between sites for consolidated processing and/or storage. This approach not only increases the cost-effectiveness of decommissioning but also provides environmental benefits and improves safety, by reducing worker dose and reducing safety risks by minimising the number of facilities to construct, operate and decommission.

B.160. The approach to waste management in the UK has generally been to manage waste at source. However, in order to develop the concept of using shared facilities, Magnox Ltd has needed to gain the support of stakeholders both at the consigning and receiving sites. Magnox Ltd. has been able to demonstrate to its stakeholders, including local planning authorities, that the use of shared facilities represents the best overall option when considered against all other credible options; and, for example, how this approach is more sustainable overall when considered against competing factors such as ‘waste-miles’ (the proximity principle).

B.161. This approach aligns with wider strategies to implement effective, optimised waste management and that provides value for UK taxpayer’s money; supporting the NDA objective to ensure that wastes are managed in a manner that protects people and the environment, now and in the future.

B.162. A good example of this is where pond caesium removal cartridges and filters were retrieved from fuel storage ponds at Dungeness A and Sizewell A (in the South East of England) for transport to Oldbury (in the South West of England) for management along with similar waste. Fuel flasks were used to transport the cartridges and filters to Oldbury, making use of existing equipment and expertise. The waste was subsequently packaged into 500L shielded drums for transport to the nearby Berkeley nuclear site where they will be stored in the existing interim storage facility until a GDF becomes available. A 3 minute video of the packing of ILW Ion-Exchange Sieve (IONSIV) filter cartridges prior to transporting them from Oldbury to Berkeley is available at the following link: www.youtube.com/watch?v=9ndJu3a63_A

B.163. As well as reducing the requirement for new infrastructure, emptying the fuel ponds of these items allowed decommissioning works to proceed in a timelier fashion than would otherwise have been the case, and consequently enabled hazards to be reduced sooner. The ponds at Dungeness A, Sizewell A and Oldbury have since been cleared and drained of water.

B.164. Elsewhere, Magnox Ltd. has been transporting waste packages from Dungeness A for storage at the Bradwell nuclear site, with over 80 moved to date. Such consolidation initiatives have resulted in fewer interim storage facilities being required and hence reduced the UK's long-term management burden.

B.165. In summary, taking a holistic view of waste arising and requirements across all Magnox Ltd. sites has allowed existing infrastructure to be used to the greatest effect. By using shared facilities the cost of decommissioning has reduced and benefitted safety.

B.166. Currently, the NDA requires that the sites it owns have an Integrated Waste Strategy (IWS), developed in line with its '[Specification and Guidance on the Content and Format of an Integrated Waste Strategy (ENG 01)]' [36]. In addition, many non-NDA sites also use this guidance to produce their own IWS, as there is value in the whole nuclear industry adopting the same approach to waste strategy development.

B.167. An IWS is aimed at providing a clear description of how wastes generated over the site's operational life and during decommissioning will be managed. This is to secure improvements in treatment and disposal routes and encourage more effective ways of working; it should demonstrate that the capability and capacity exists to manage these wastes effectively and to identify any gaps, and the actions needed to address them. The Specification emphasises the importance of the waste management hierarchy as a framework for waste management decision making to enable an effective balance of priorities including value for money, affordability, safety and the environment, and aims to increase levels of recycling and reuse, with disposal as the last resort option.

B.168. Sellafield has recently updated its IWS. As Sellafield moves its focus from reprocessing to decommissioning and environmental remediation of the site, the importance of waste management increases. The IWS is intended to enable a culture where waste management is at the heart of delivery and provides a framework for effective decision making across the organisation. It describes Sellafield's approach to establish strategic capability for waste management throughout the site lifetime to ensure best use of waste management capabilities to support the mission and to drive continued development and improvement. The IWS is cascaded into delivery arrangements through integrated waste management programmes and plans and site- and facility-level processes/procedures.

B.169. Effective integrated waste management will enable the delivery of the Sellafield mission by optimising waste management, through sustainable, robust, timely and fit for purpose waste management routes. In particular, to reduce the hazard and risk of the legacy ponds and silos as soon as is reasonably practicable and to prepare facilities and infrastructure to receive wastes.

B.170. The NWP continues to promote and deliver improvements in management of LLW, through sharing of best practice, and creating a sustainable infrastructure providing pragmatic LLW management solutions. The NWP blueprint [37] describes the delivery of the NWP and the strategic benefits to be achieved. These include ensuring that decommissioning projects are waste management informed, that LLWR Ltd's waste services supply chain is aligned to waste producer's needs and risk-informed disposability approaches are developed and implemented to divert LLW away from the LLWR. The overall performance of the programme is reported monthly in the publicly available national Waste Metric Dashboard [38].

B.171. One notable area of progress achieved by the NWP is in relation to managing borderline or boundary radioactive wastes (i.e. those with radioactivity around the boundary of LLW and ILW).

Reclassification opportunities for ILW, enabling early solutions

B.172. Effective management and characterisation of radioactive waste can lead to opportunities to reclassify ILW and sentence it to existing disposal routes, reducing ILW volume needing to be stored pending a GDF becoming available, and realise substantial cost savings.

B.173. In the last 10 years, approximately 98% of LLW created in the UK has been diverted away from disposal in the LLWR to alternative treatment and disposal routes. This successful change in approach has led to waste producers thinking differently about how some of their inventory currently identified in the UKRWI as ILW, could be managed.

B.174. Through a range of approaches, including decay storage, additional characterisation, sort/segregation, treatment and conditioning, a number of populations of ILW waste have been reclassified as LLW suitable for disposal to the LLWR:

- A significant proportion, around 50%, of the FED at the Bradwell site was identified as LLW and met the acceptance criteria for the LLWR after conditioning. Diversion of this waste supported the Bradwell site to enter extended C&M earlier than would have otherwise been possible and has led to Magnox Ltd exploring opportunities for FED stored at some of their other sites to be managed in the same way, providing more prompt disposal;

- Over 1000 stainless steel drums of encapsulated waste have undergone decay storage at Magnox Ltd's Winfrith site, allowing them to be sent for disposal to the LLWR over the next few years. This early disposal reduces the burden for a future GDF;

- Thousands of drums of Plutonium Contaminated Materials (PCM) waste are currently stored at Sellafield. Historically all waste arising from facilities containing PCM was assumed to be ILW and therefore managed as such. New assay equipment installed in the engineered store has enabled some of the PCM waste to be better characterised and disposed of as LLW. These drums are super-compacted before sending to the LLWR for disposal to maximise volume reduction. The experience gained from this work is being shared with other UK sites which have inventories of PCM waste to see if they could adopt a similar approach;

- Concrete boxes containing waste from the historic Windscale Advanced Gas Reactor (WAGR) were packaged as ILW during the decommissioning of the WAGR facility many years ago. More recently Sellafield identified that some of these packages were likely to be LLW through decay storage and better characterisation. A project has therefore been initiated to identify and collate the information needed to demonstrate their acceptance for disposal as LLW.

B.175. While these projects take resources and time to demonstrate that the waste can be diverted from ILW storage for disposal as LLW, they deliver significant benefits. This includes early safe and compliant disposal of the waste; reduction in risk; and freeing up space in highly engineered ILW stores to support the NDA's decommissioning mission.

Borderline Waste Management at Magnox Ltd

B.176. A key area of focus in recent years has been to optimise the management of 'borderline ILW/LLW waste' – that which could be managed, wholly or in part, as ILW or LLW depending on the chosen management strategy.

B.177. For example, at the Magnox Ltd. Bradwell site, the original management strategy for FED (cladding / components used to hold fuel elements within the reactor core) involved treatment via dissolution, a process which used acid to dissolve the vast majority of the FED metal, leaving a greatly reduced volume of waste to manage. However, difficulties with implementing this technology prompted a strategy review.

B.178. FED was first retrieved from legacy storage locations and then transferred into drums where characterisation could be more accurately performed. The result was that a significant proportion, approximately 90 te, of the (now segregated) waste was LLW and therefore could be managed as such. The significant benefit of this is highlighted by the fact that only 65 te of FED was managed through dissolution over a period of many years.

B.179. The LLW was demonstrated to be suitable for disposal at the LLWR after conditioning and use of this disposal route was subsequently deemed to be optimal for this portion when balanced against all relevant factors. By adopting this strategy, the Bradwell site achieved its interim state much sooner than would otherwise have been the case and preserved valuable storage space within its Interim Storage Facility (ISF).

B.180. The learning from this work is now being applied in development of plans for borderline FED at Oldbury and Sizewell A, and being used to inform plans for managing borderline wet wastes more generally.

Management of legacy facilities and wastes

B.181. As outlined in the sixth UK NR, there remain significant long-term challenges in relation to decommissioning legacy nuclear facilities in the UK, particularly at Sellafield and with the Magnox nuclear power stations. The relevant issues and progress, with emphasis on the radioactive waste practices being used, are described below.

Sellafield

B.182. Sellafield was the site of much of the pioneering work at the beginning of the UK's nuclear industry. Over the last 80 years it has led the development of the industry, carrying out activities including the production of plutonium for the country's nuclear weapons programme, the development of nuclear fuel manufacture and spent fuel reprocessing (Figure 10). However, with the imminent end to reprocessing, the focus of the Sellafield site is now on decommissioning and clean-up of the legacy from the site's early operations, including some of the most hazardous nuclear facilities in Europe. Accordingly, the site mission is to *'Safely and securely remediate the Sellafield site to benefit the industry, nation and region'*.

Figure 20: History of the Sellafield site

B.183. The challenge to deliver this mission is a substantial one. The Sellafield site is one of the largest and most hazardous nuclear facilities in Europe; it processes and stores more radioactive material per square metre than any other nuclear facility in the world. The site comprises more than 250 nuclear facilities and over 1000 buildings, with a wide diversity in plant and facilities, reflecting the site's long and varied operational history. Many of the facilities on the site were constructed quickly post-war, in pursuit of the UK's nuclear weapons programme, with little thought being given to their subsequent decommissioning.

B.184. One of the most significant challenges relates to the waste retrieval from, and decommissioning of, some of the above legacy facilities which are degrading, and fall well below the high standards expected from modern nuclear facilities. Such has been the degradation of some of these high hazard facilities that retrieval of their radioactive inventory requires complex, novel and intrusive interventions over a period of many years. This includes a significant quantity of ILW in raw (unconditioned and un-passivated) form in legacy ponds and silo facilities. There has been significant investment and development of capability and infrastructure to retrieve and manage wastes from these legacy facilities, but the work will take many years to complete.

B.185. In addition to the magnitude and nature of the nuclear hazards at Sellafield, is the very congested layout of the site; with facilities in very close proximity to one another. There are also complex interdependencies between process and waste facilities which can impede progress should one facility experience operational problems. These factors, as well as the need to characterise, package and safely store a large inventory of radioactive material in existing and new facilities further exacerbate the difficulties of undertaking the necessary decommissioning and hazard reduction work. As there is not yet an operational disposal route for HAW in the UK, radioactive material will continue to accumulate on the site pending its ultimate disposal in a GDF when one becomes available. All of the above makes for a challenging environment for Sellafield Ltd, as licensee, and for the regulators.

B.186. The imperative to reduce the risks posed by these facilities and the challenging nature of decommissioning activities necessitates the use of an enabling approach to regulation that empowers the use of pragmatic and innovative approaches to achieve timely and effective decommissioning. Colloquially this is often referred to as the 'decommissioning mindset'. This does not remove or diminish the requirement for operators to be compliant with legal requirements and reduce risks to be as low as reasonably practicable (ALARP), rather it provides a flexible approach, accepted by regulators, that can be used as appropriate to consider what is reasonably practicable in a particular case to expedite remediation of high hazard facilities.

B.187. At the core of the 'decommissioning mindset' is the need for all stakeholders to acknowledge the high level of risk presented by legacy facilities and to recognise that a 'business as usual' approach is no longer appropriate. Instead, operators, regulators and government must shift their tolerance of risk to reflect the fact that well-managed increases in short-term risk, as a result of undertaking decommissioning, must be accepted in order to secure an overall and longer-term larger risk reduction, through elimination of the hazard. This may mean introduction of work approaches that introduce short-term risks higher than those that would normally be acceptable, although these should still be controlled to be ALARP.

B.188. This is illustrated generically in Figure 11, which shows that carrying out some activity (for instance making penetrations into a legacy facility to enable waste retrieval operations to be progressed), may incur a short term increase in risk, but, by progressing the activity (leading to the removal of radioactive waste), it results in a significant long-term reduction in the overall hazard and risk.

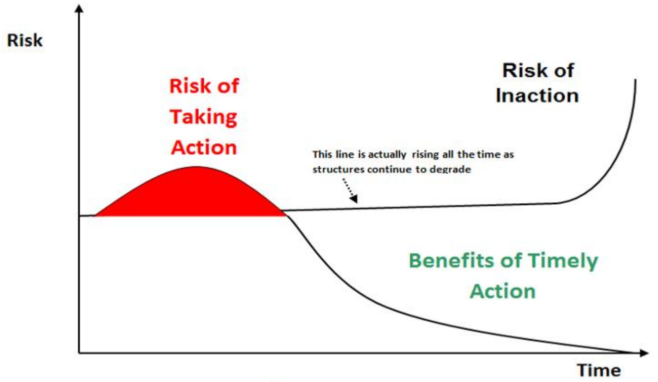


Figure 22: Concept of the balance between short- and longer-term risks that is critical to application of the decommissioning mindset. A short-term increase in risk due to carrying out some decommissioning work leads is justified in the interests of a larger and longer-term risk benefit.

B.189. Where the 'decommissioning mindset' is being applied to secure timely and effective remediation from high hazard facilities, the engineering emphasis should be on considering innovative solutions, applied in a fit-for-purpose manner, rather than defaulting to the very conservative and highly optimised solutions that are more typical of nuclear operations such as operating reprocessing facilities or reactors or in new build. In addition, it is recognised that increased reliance must sometimes be placed on human actions and mitigating measures (instead of prevention), where this is justified.

B.190. The adoption of the 'decommissioning mindset' by all stakeholders, enabled by the UK's goal-setting regulatory framework, has led to a significant improvement in the approach to decommissioning hazardous facilities in the UK, including progress towards the decommissioning of the legacy ponds and silos at Sellafield and the shut-down Magnox power stations.

B.191. The UK now has a wealth of experience in the application of the 'decommissioning mindset', both in terms of the engineering, safety case and interactions between different organisations. The key principles that have led to the success of the 'decommissioning mindset' are as follows:

- Prioritisation – focussing on activities with most impact on hazard and risk reduction and gaining agreement with relevant stakeholders, including the NDA and regulators;
- Removal of barriers to progress – minimising blockers, diversions and distractions, such as unnecessary bureaucracy, to maintain focus on priorities and driving forward progress at pace;
- Fit-for-purpose solutions – development and use of straightforward and pragmatic solutions, not overly complex designs and processes, to achieve maximum value in terms of delivery, reliability, and operability;
- Balance of risk – ensuring a balanced and proportionate regulatory approach, recognising that there may be an unavoidable temporary increase in risk in some facilities in order to reduce long-term risk and hazard;

- Appropriate incentives – creation of an environment and culture that promotes the delivery of value in terms of focus on priorities, schedule- and cost-effectiveness in delivery;
- Communication – co-ordinated and risk-informed discussions between all of the key stakeholders required to achieve progress – duty-holders, regulators and government – whilst continuing to engage open and honestly with local, national and international communities.

B.192. This concept is embedded within Sellafield's approach to decommissioning and brings all the stakeholders involved with the remediation of Sellafield together and is referred to as the 'G6'. The G6 working group, comprising of UK government, Sellafield, NDA and regulators, facilitates a constructive approach towards the common objective of delivering the Sellafield mission. The G6 promotes a collaborative approach between these organisations to encourage innovative thinking and effective approaches to reducing hazard, the balance of risk in the short term and an enabling approach to removing barriers to making progress.

Legacy ponds and silos

B.193. The legacy ponds and silos facilities are principally made up of the:

- Pile Fuel Storage Pond (PFSP);
- First Generation Magnox Storage Pond (FGMSP);
- Magnox Swarf Storage Silo (MSSS); and
- Pile Fuel Cladding Silo (PFCS).

B.194. The retrieval of waste from the legacy ponds (PFSP and FGMSP) has progressed significantly since the sixth UK NR. A substantial inventory of materials, including pond skips and other pond furniture, sludge and miscellaneous items such as ion-exchange cartridges, has been retrieved from the ponds to safe storage or disposed of. This waste will be stored safely in dedicated waste stores elsewhere on site, pending its disposal.

Progress with the retrieval of Pile Fuel Storage Pond fuel and sludge and encapsulation of sludge

B.195. Since the sixth UK NR, Sellafield has made significant progress with the retrieval and processing of legacy ILW from one of its oldest and highest risk facilities.

B.196. PFSP (Figure 12) is the oldest storage pond on the Sellafield site, originally designed to receive and cool spent fuel from the Windscale reactors. Emptying and processing waste contained within it has been a priority for the UK for several years.

Figure 24: The Pile Fuel Storage Pond

B.197. Out of the 752 tonnes of waste originally in the pond, 362 tonne has been removed, including 121 skips (out of 186), for safe storage. Around $30m^3$ of pond sludge has also been retrieved for encapsulation and safe storage on site.

B.198. Most of the spent fuel has been removed from the pond, with around 3 te still remaining. Other pond inventory includes ILW in pond skips, IONSIVs, isotope cartridges and sludge. Sellafield has worked with external contractors to develop a new disposal route for the IONSIVS through the Sellafield waste encapsulation plants. The first 10 of these have been moved six years ahead of schedule, removing around 10% of the remaining radioactivity in the pond.

B.199. The inventory reduction curve for PFSP (Figure 13) shows that all waste is expected to be removed from the pond by 2024. This demonstrates a significant acceleration of ILW retrievals over the previous 2014 plan, achieved by realising an opportunity to use existing downstream plants to support retrievals rather than require new facilities to be constructed.

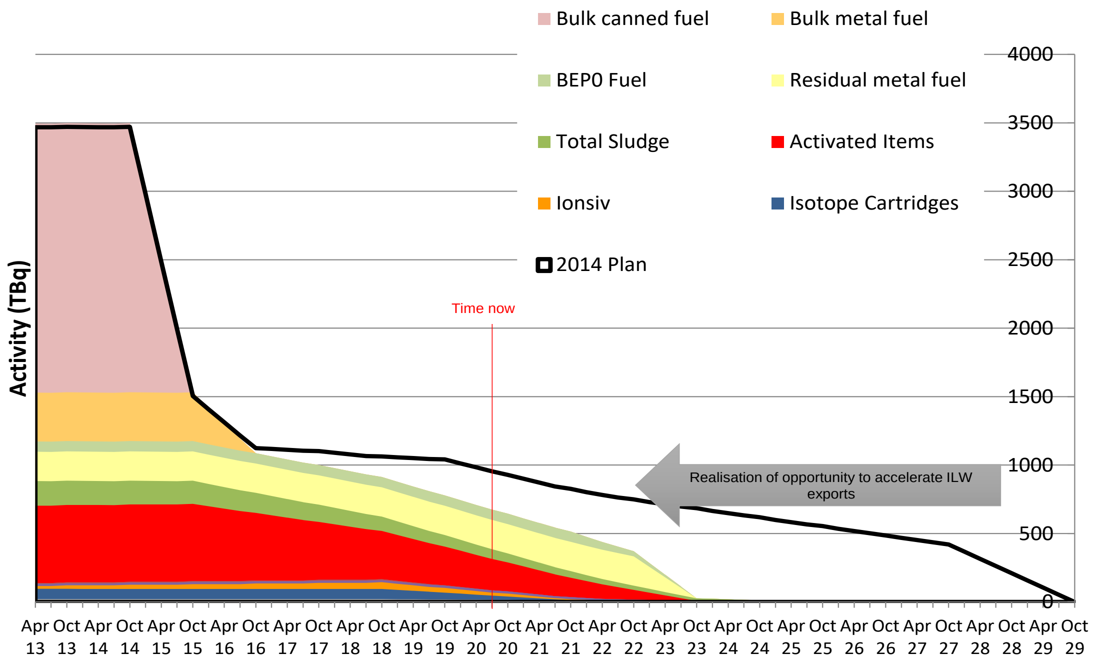


Figure 26: PFSP inventory reduction curve

B.200. Once all the inventory has been removed the pond will be drained and placed in an interim state. Pond draining is currently planned to be complete by 2029.

Progress with the retrieval of First Generation Magnox Storage Pond Fuel and Treatment of Sludge

B.201. Since the sixth UK NR, Sellafield has made significant progress with the retrieval and export of spent fuel from FGSMP, exceeding planned targets and reducing one of the highest risks at the site.

B.202. FGMSP (Figure 14) was used to receive, cool and process spent fuel from the UK’s Magnox nuclear power stations (and some fuel from other countries).

B.203. The original challenge within the facility included 14,000 m^3 of contaminated water, 1,400 m^3 of radioactive sludge, 500 te irradiated fuel and 2,100 m^3 of solid ILW

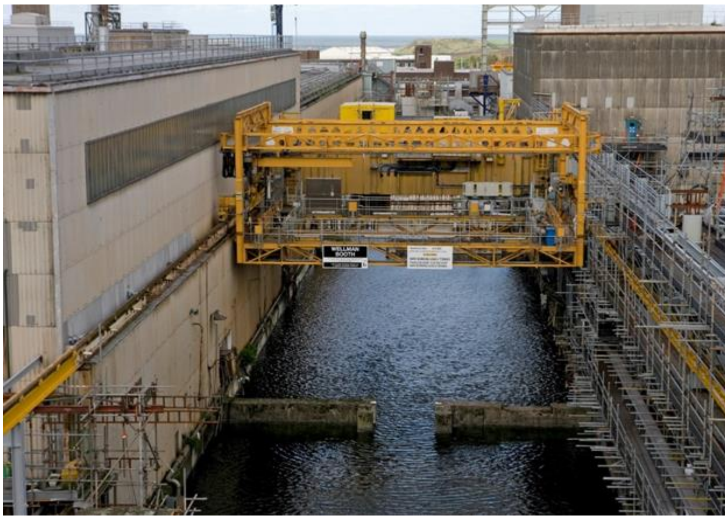


Figure 28: First Generation Magnox Storage Pond

(Figure 15).

B.204. At the time of writing around 132 te of fuel, 136 m^3 of sludge and 49 m^3 of solid ILW have been retrieved from the pond for safe storage on site. In addition, 60 empty skips have been removed to create operational space to provide access to the sludge.

B.205. The remaining pond inventory includes spent fuel, skips of ILW, zeolite (an ion-exchange medium) skips and sludge. Waste continues to be removed from the main pond which is expected to be empty by 2031.

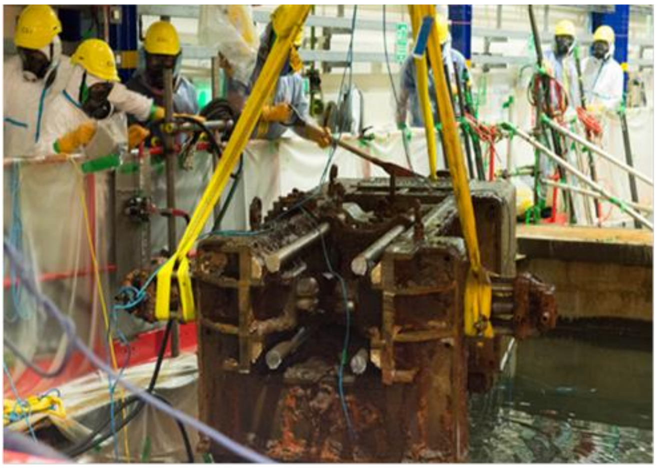


Figure 30: Example of the removal of a bulk solid item from ponds

B.206. Another stream of work is cleaning up the D-bay area of FGMSP (a submerged maintenance bay off the main pond). The bay has been accumulating radioactive sludge formed from corroding nuclear fuel since the 1970s and now roughly holds 250 m^3 of radioactive sludge and other debris. It is a high priority due to the proximity of the sludge to the surface of the water, the sheer volume of radioactive material and the ageing concrete structure.

B.207. The work is largely being done remotely using manipulator robots, with the operators being shielded behind a wall. The robotic arms are attached to an overhead travelling crane and various tools can be attached to the arm for different tasks, such as lifting items and carrying out size reduction. A suction device is being used to “hoover up” the sludge, which is then transferred to the sludge packaging plant (SPP1) for onward safe storage. A short 30-second video of the sludge suction device being used in D-bay is available at the following link: https://youtu.be/K2rSV7aqtLA.

B.208. Once PFSP and FGMSP have been emptied of all solid wastes, they will be drained and put into an agreed interim end-state. This may involve decontaminating the pond surfaces as far as is practicable to minimise any residual contamination and thereby minimise future legacy waste material produced at final site clearance.

Development of approaches to decontaminating cooling pond surfaces

B.209. Sellafield has investigated innovative techniques for decontaminating and cleaning surfaces in cooling ponds.

B.210. Innovative approaches are being investigated. For instance, PFSP has trialled using an adapted swimming pool cleaning machine to clean the pond walls (Figure 16). Similarly, a scheme involving deployment of divers is being developed for a pilot project for remediation of PFSP, known as the Bay Interim State Pilot (BISP).

B.211. BISP is being undertaken to develop the skills, tactics and tooling necessary to clean-up and drain PFSP. The bays currently contain solid debris and sludge (Figure 17).

Figure 32: Trials of an adapted swimming pool cleaner to clean surfaces in PFSP

Figure 34: PFSP Bays 11 and 12 showing solid debris and sludge

B.212. The solid debris and sludge will be removed using a sludge pump and a micro-digger may be deployed (Figure 18). This equipment will not be able to access all the bay areas (particularly some trenches). Divers will be deployed to clean-up these areas to an acceptable state (building on experience gained by Magnox Ltd in using divers for pond clearance; as described in paras B253-B258).

Figure 36: A micro-digger used to clear solid debris from PFSP bays 11 and 12.

B.213. Once the debris and sludge is removed, the bays will be incrementally drained and the exposed concrete wall surfaces shaved or shielded to reduce the high dose rates from the embedded contamination in them. Any remaining debris will be entombed in a newly poured concreted floor.

B.214. Substantial progress has been made in preparations for retrieving wastes from MSSS and PFCS. This has involved development and commissioning of retrievals equipment. In particular, in order to expedite retrievals, the wastes will be retrieved and stored in dedicated waste stores but in an unconditioned and non-passively safe state, with any conditioning that may be needed deferred until a later date.

B.215. The nature of the MSSS waste, and to a lesser extent the PFCS waste, is that it is still chemically reactive and generates heat and hydrogen, posing risks for flammability and deflagration during storage. To address this, Sellafield is approaching the completion of the development of a challenging 'safe to store' safety case which substantiates the safe retrieval and storage of these wastes in discrete packages within a modern store. Once this case has been appropriately assessed by ONR, the retrievals will commence. This is currently planned to be in late 2020.

Preparations for waste retrievals from Magnox Swarf Storage Silo

B.216. Sellafield has made progress in preparing to retrieve ILW from the legacy MSSS (Figure 19), one of the highest hazard legacy facilities in the UK, by installing the first of three Silo Emptying Plant (SEP) machines. An 8-minute video giving an overview of work to retrieve wastes from MSSS is at available at the following link: https://www.youtube.com/watch?v=qQwky909RVQ.

B.217. MSSS has 22 individual compartments, holding around 11,000 m^3 of ILW. The ILW is stored under water, with building ventilation managing the hydrogen being generated.

B.218. SEP machines, each weighing around 360 te and comprising mobile, heavily shielded caves, which will be positioned over each compartment. The ILW will be retrieved into the SEP machine using a “fairground” grab and transferred to a suitable waste package for dispatch for safe storage on site. A 4-minute video showing the installation of a SEP machine and the operation of the grab is available at the following link: https://www.youtube.com/watch?v=fkfGx80vmd4.

B.219. There will be three SEP machines, eventually all working in parallel, to achieve sustained retrievals. Currently one SEP machine is fully built and installed, with the second under construction. The first piece of the second machine, a transfer tunnel, was installed in December 2019. The expectation is that all three machines will be operating by around 2024 with retrievals set to be complete by 2045. A one minute video of the early stages of installation is available at the following link: www.youtube.com/watch?v=6XSKtsRFPXY&feature=youtu.be.

Figure 38: Magnox Swarf Storage Silo

B.220. There has been a successful trial lift of a waste transfer package into the facility. The 50 te package was safely placed onto the first SEP machine. The waste will be removed from the compartments and placed in the transfer package before exiting the building via the transfer tunnel. The first transfer package was manufactured by a local supplier and is one of nine original packages they have built and modified for Sellafield.

B.221. Another stream of work that started in 2018/19 was the transfer of liquor from the first extension of the plant into the third extension so that it can be transferred to the Sellafield Ion Exchange Plant (SIXEP) for treatment, to reduce the radioactive content of liquor associated with the solid waste storage. The first extension was previously impossible to access, but the team used remotely operated vehicles (ROVs) to link up hydraulic pipes that were part of the plant’s original overflow channel to provide a route for the liquor transfer.

B.222. In 2019, Sellafield Ltd reported two incidents where leakage of radioactively contaminated water (liquor) was detected from legacy facilities, namely the Redundant Settling Tank (RST) and MSSS. These incidents were rated at level 1 and level 2, respectively, on the International Nuclear & Radiological Event Scale (INES). They also met the criteria for requiring reporting to government ministers [39]. These incidents and the remedial action taken in response are detailed below.

B.223. RST is an open-topped cast concrete sump tank used to receive and settle sludge from FGMSP which is in the legacy pond area of site. The tank had been subject to POCO before 1995 but still contained a quantity of ILW sludge and assorted solid debris. Following routine maintenance work to remove some debris from the tank, the level of liquor in the sump started to fall. The leak is believed to be through a historic leak path to the ground below the sump. To stop the leak, Sellafield has safely removed the waste and debris in the tank and intends to cap the RST sump with concrete.

B.224. MSSS stores waste under water cover to shield, cool and prevent fire in the waste. Routine liquor level monitoring revealed an apparent loss of liquor to ground from the facility. The liquor is believed to be leaking into the ground from cracks in the MSSS original building structure below ground level. The cause of the on-going leak is currently unknown, but a possible leak mechanism is the reopening of a crack associated with a leak in the 1970s as the rate of leakage is comparable to estimated leak rates observed at that time. The liquor level in the silos is maintained by water top-up to ensure that the waste continues to have sufficient water cover and remains safe. Mitigating or even preventing the leak is a complex challenge. ONR judged that due to the nature of MSSS and the large quantities of stored radioactive waste, the most effective way to remediate the leak is for Sellafield Ltd to continue with its long-term programme to remove the waste as its highest priority.

B.225. These leaks do not have any immediate consequences for safety. There has been no health risk or increased radiological doses to the workforce or the public from either event. There has been no detectable change to the general radiological conditions in MSSS.

B.226. The precise amount of radioactivity released into the ground from these leaks is not known. However, the amount is estimated to be low relative to the very substantial contamination already present as a result of historic leaks.

B.227. Sellafield Ltd carries out extensive ground water monitoring around the Sellafield site through a network of boreholes. Ground modelling and underpinning research concludes that any radioactive material will bind itself to the clay present in the soil, ensuring that any migration will be very slow. As such, any risk to the environment and public would be very low and over an extended timescale. There is no risk of public water supply boreholes being affected by the leak or drawing any contaminated water towards them.

B.228. Both ONR and EA engaged closely with Sellafield Ltd on these incidents and continue to maintain close oversight of Sellafield Ltd's leak to ground risk management plan to inform future regulatory interventions.

Preparations for waste retrievals from Pile Fuel Cladding Silo

B.229. Sellafield has now established the retrievals processes to remove wastes from PFCS (Figure 20), one of the highest hazard legacy facilities in the UK and the oldest waste storage facility on the Sellafield site - dating back to 1952.

B.230. PFCS has six individual compartments, holding around 3,400m^3 of ILW. The ILW is stored under an inert argon atmosphere. As described in the sixth UK NR, retrievals access penetrations were made into the side of each compartment to provide access for waste retrievals equipment (Figure 21). A short video showing the creation of these penetrations is available at the following link: https://www.youtube.com/watch?v=b2lf55Hcq_Q.

B.231. Since then, the retrievals equipment and process have undergone trials and been developed to the point of operational readiness. Machinery to remove waste is now in place. The retrievals equipment is contained in nine large modules which were lifted into place on top of a modern 'superstructure' built on the side of the building as the original building was not structurally strong enough to have additional weight built on top of it. A 5-minute video showing the installation of the retrievals equipment at PFCS is available at the following link: https://www.youtube.com/watch?v=uYMYiSItSdI.

B.232. The expectation is that retrievals will commence later in 2020 or 2021.

B.233. To remove the waste, a crane will extend through the hole in the side of the silo, a grabber will be lowered to scoop-up the waste, the grabber then lifts and retreats back through the hole before depositing the waste in a specially-designed metal box, for safe and secure storage in a modern facility which is currently being built at the site.

Figure 40: Pile Fuel Cladding Silo

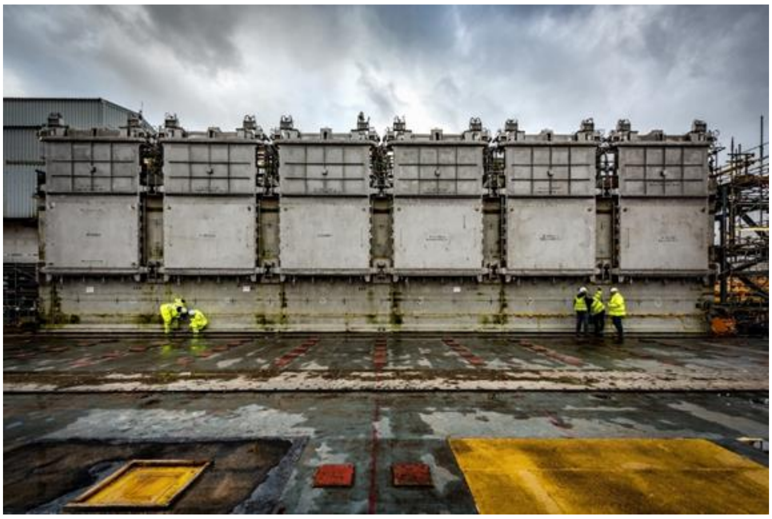


Figure 42: Penetrations into each PFCS compartment, each sealed with a steel door

B.234. There has been significant further progress made in decommissioning other parts of the Sellafield site; one example is given below.

Demolition of chimney stacks

B.235. Innovative approaches have been used by Sellafield to make substantial progress with the demolition of the first-generation reprocessing plant and Windscale reactors chimney stacks. These structures no longer met modern standards, and their proximity to hazardous nuclear buildings, made their demolition a complex task and a priority.

B.236. The first-generation reprocessing plant stack at 60 metres tall was the highest stack at Sellafield. Over a 30 month period, the stack has been reduced down to 9 metres, a height which gives it acceptable seismic withstand and ensures that it no longer poses a risk to nearby high hazard plants in the event of a collapse (Figure 22). Conventional demolition using explosives was not possible given the location of the stack; instead, it was demolished by workers using hand tools from a climbing platform, which used friction alone to hold to the stack.

B.237. In total, around 400 te of concrete and 30 te of steel were removed. The project highlighted effective collaboration between Sellafield and demolition and lifting experts and steeplejacks. A short 3 minute video of the project is available at the following link: https://youtu.be/x_NfhV-J5wY

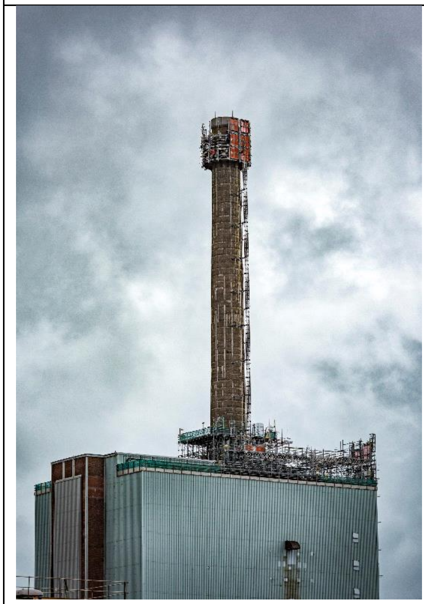
Before	After
	

Figure 44: Height reduction of the first generation reprocessing stack

B.238. The demolition of the remaining ventilation chimney for Windscale Pile 1 (scene of the fire in 1957) has been safely progressing. The ‘filter gallery’ at the top of the stack, which was highly contaminated as a result of the 1957 reactor fire, was removed in 2014. Since then work has focussed on removing the diffuser from the top of the stack.

B.239. A tower crane was used for the first time on the Sellafield site (Figure 23) and using learning from work outside Sellafield led to the adoption of an approach to cut the structure into large blocks using a diamond wire technique and moving the cut blocks to the ground by crane, for characterisation and sentencing for disposal.

B.240. So far, more than 5 metres have been removed, equating to 136 blocks, with a cumulative mass of 794 te.

Figure 46: Tower crane on the side of the Windscale chimney pile 1

Magnox Ltd nuclear power station sites

B.241. The decommissioning of the shut-down Magnox fleet of nuclear power stations (26 reactors on 11 sites), is well underway, but will take decades to complete. A key milestone was reached since the sixth UK NR in that all Magnox reactors have now been fully defueled and verified to be fuel free. All the spent fuel from these sites is consolidated in safe storage at Sellafield prior to reprocessing.

B.242. As mentioned in Section A – Introduction, until recently the strategy for all of the Magnox reactor sites was that decommissioning be deferred by putting them into an extended period (between 40-70 years) of C&M, prior to final site clearance. This approach was intended principally to accrue the safety benefits from radioactive decay. The Bradwell nuclear power station entered C&M in late 2018 and was the first site in the UK to enter this stage (see case study below). Bradwell established a benchmark for the C&M state in terms of aspects such as achieving passive safety of the remaining contamination and wastes on site and the extent of monitoring and inspection required during this phase to ensure the site stays in a safe condition. It also established the regulatory approach to providing permission to a site moving into C&M. This learning will be directly relevant to decommissioning AGR power stations, which will cease operations and enter into decommissioning over the coming years.

B.243. Magnox Ltd and NDA have reviewed the experience gained from Bradwell and the actual costs of deferral are now better understood. Bradwell has demonstrated that deferral may not always represent the optimal approach, particularly for the earlier reactors. This learning has led to a change in strategy whereby site-specific considerations will inform the decommissioning programmes on each site. For some sites this is likely to result in their decommissioning being brought forward while others will continue to be deferred for a period that suits conditions on that site. It is anticipated that together this will result in a rolling programme of activity across the fleet of Magnox reactor sites.

First UK nuclear power station (Bradwell) to enter an extended period of Care and Maintenance

B.244. In October 2018, Magnox Ltd. put the Bradwell site into an extended period of C&M (Figure 24), marking a significant achievement for the UK's decommissioning efforts. The work at Bradwell was a first-of-a-kind for the UK and the lessons learnt are being applied to the other Magnox sites. Deferral may not be the most cost-effective option, particularly for the earlier Magnox stations where no thought as to their decommissioning was given during the design stage. In some cases the cost of maintaining the facilities in a safe condition during deferral, outweigh the costs of their earlier removal.

B.245. This work involved the removal of redundant plant and structures, with all associated and historically stored wastes, both radioactive and conventional, being managed. The remaining features at the site have been readied for secure, passively safe storage. As part of this, the reactor buildings were fitted with a weatherproof cladding covering 29,000m^2.

B.246. ILW management was affected through the use of DCICs and vacuum drying technology used to dry a range of wastes (including pond sludge). All of the resulting waste packages now reside in the on-site ISF where they will be kept until a GDF becomes available. The ISF at Bradwell was the first of its type and is based on a scalable design that has since been replicated at Berkeley, Chapelcross and Hinkley Point A; its design life is over 100 years.

B.247. Radioactive waste practices were optimised during decommissioning through the development and application of effective characterisation, decontamination, segregation, and co-packaging techniques. The dissolution of FED along with the increased use of LLW disposal routes, enabled by early waste retrievals, resulted in vastly reduced volumes of ILW to package. More generally, these techniques enabled radioactive wastes to be effectively categorised and managed, resulting in an increased proportion of waste being consigned as non-radioactive.

B.248. Key operational lessons learnt for future work include:

- fully consider the sequence in which work is conducted. For example, the early demolition of structures can provide benefits to the rest of site projects, and 'laydown' requirements should not be underestimated;
- invest in waste characterisation to avoid time and cost increases later on. If the waste is not understood its management cannot be optimised. The early retrieval of waste can support this, and simple retrieval methods tend to be best;
- avoid implementing unproven technology on time-critical projects, and include sufficient levels of contingency in project plans;
- deferral may not be the cheapest option, particularly for the earlier Magnox designs where no thought as to their decommissioning was given during design. Often the cost of keeping the assets in a safe condition during deferral outweigh the costs of removal; and

- encourage open and honest communication with all stakeholders to ensure that common objectives are widely understood. This best helps to manage workforce motivation throughout all stages of decommissioning and facilitates the necessary co-operation needed with the regulators.

Figure 48: Bradwell during C&M preparations (left). Bradwell in C&M (right)

B.249. Nearly 1,000 people worked at Bradwell at the peak of its decommissioning, and over the course of this work:

- a total of 90,000 te of waste were generated and managed;
- 95% of this was managed as non-radioactive waste, and:
    - 66% of this was recycled,
    - 24% of this was reused as infill on site,
    - 10% of this was disposed of;
- more than 4,000 te of asbestos were removed from site.

B.250. A short 4 minute video of the project can be found at the following link: http://youtu.be/Cc61QorzLac. Further information is also available in a publicly available leaflet entitled ‘Bradwell entering care and maintenance’.

B.251. The remaining features will be kept in a passively safe and secure state for a number of decades, allowing radiation levels within them to decay over time before the reactors are dismantled and the site is cleared. The site will be monitored continuously, with planned maintenance and inspection activities undertaken at regular intervals.

B.252. An extensive knowledge and information data library has been established to store all relevant records generated during the course of this work (see para B288 for further details). The information stored in this library will not only enable final decommissioning of the Bradwell site towards the end of this century but also inform the decommissioning approach used at other UK sites.

Decommissioning of Magnox Fuel Storage Ponds

B.253. Magnox Ltd. has significantly progressed the emptying and clean-up of spent fuel ponds using a range of innovative approaches such as divers and remote handling equipment as well as developing new effluent treatment techniques.

B.254. Each Magnox reactor site (with the exception of Wylfa which operated a dry fuel route) had ponds which were used to store spent fuel awaiting transport to Sellafield for reprocessing. The ponds were also used to store items of waste which arose during reactor operations. In addition, radioactive sludge accumulated in the ponds during their operation.

B.255. Work to decommission the ponds at each site has been taking place. Each pond will either be promptly demolished or stabilised so that they can be safely managed until demolition or be considered for potential in-situ disposal, should this option become available. Whichever approach is followed, the ponds first need to be emptied of all items, drained and appropriately decontaminated. These activities have made extensive use of common solutions and cross-site learning. A short video showing pond decommissioning at Oldbury is available at the following link: https://www.youtube.com/watch?v=1gH17vnK-FA.

B.256. HAW items have generally been sorted and segregated underwater due to their high dose rates. This work employed a variety of techniques, latterly using a set of three ROVs with one manoeuvring a sludge collection hose, one monitoring for solid high dose rate items and one segregating such items for waste processing (Figure 25).

Figure 50: Use of underwater ROVs (left) and divers (right) at Sizewell A

B.257. Items which are less radioactive have historically been sorted and size-reduced 'in-air' during drainage of the pond or once the pond has been drained. An alternative method used at Dungeness A and Sizewell A involved divers performing such activities underwater (Figure 25). This innovative approach, building upon international experience (including using divers from the USA with relevant experience), was highly successful in reducing overall doses, timescales and cost. For example, diving works at Sizewell A were completed significantly ahead of schedule and involved:

- 11 divers;
- 447 dives (1,119 hours) without a safety or contamination event;
- size-reduction of 35 HAW (empty) fuel storage skips;
- de-planting and size-reduction of 75 te of LAW pond 'furniture'.

A 3-minute video showing divers working in the Sizewell A pond is available at the following link: https://www.youtube.com/watch?v=EQKrd409W_A.

B.258. All but one pond (at Chapelcross) has now been drained and the concrete walls and floors partially decontaminated using a range of techniques. These include mechanical removal (concrete shaving and scabbling), ultra-high pressure water jetting, low and high pressure water jetting, as well as non-aggressive cleaning methods (Figure 26).

Figure 52: Use of pressure washing from a walkway (left). Fully drained pond (right).

B.259. Associated with the ponds are facilities used to treat radioactive liquid effluents that arise. To enable these facilities to be taken out of service and decommissioned, Magnox Ltd. has developed a modular active effluent treatment plant (MAETP). The generic MAETP design has the capability to abate both particulate and soluble radionuclides, and be tailored to meet the requirements of each site through selection of the appropriate modules. To date, the MAETP modules have been installed at Dungeness A and Hinkley Point A and one is due for installation at Chapelcross during 2020.

Remediating land at Harwell for alternative use

B.260. Magnox Ltd. has excavated more than 45,000 m^3 of soil and debris at Harwell to enable part of the nuclear site to be used for non-nuclear, industrial / commercial purposes (Figure 27).

B.261. Harwell is located in an area of outstanding natural beauty in Oxfordshire and today forms part of the Harwell Oxford Campus, a major science and technology centre. But the site has a long association with the nuclear industry being Britain's first civil nuclear research establishment. Construction began at the site in 1946 with the development of a range of research and development facilities, including the first research reactors (GLEEP – Western Europe's first reactor, British Experimental Pile 0 (BEP0), LIDO, Zeta, DIDO and PLUTO), accelerators, radioactive handling facilities and laboratories.

B.262. This diverse and complex site was provided with a liquid effluent treatment plant (LETP) which historically processed all liquid waste arising from the site's operations, undertaking the chemical and radiochemical monitoring and clean-up treatment of liquid wastes before they were discharged. The LETP has been decommissioned in recent years with all above ground structures removed. An 8-minute long video on the LETP land remediation is available at the following link: http://www.youtube.com/watch?v=imoh3UvjPdA.

B.263. The decommissioning programme at Harwell will progressively release land and buildings making them available for their next planned use. However, the land on which the LETP was sited is required for prompt reuse (in this case, a mixture of light industrial and residential use is expected). Therefore, the objective is to remove all remaining structures and radioactive liabilities so that the land will no longer be subject to an environmental permit or nuclear site licence.

B.264. To date, more than 45,000m^3 of soil and debris has been excavated, assayed and disposed of off-site. The waste is dug using excavators and placed into bags via hoppers for assaying in a bespoke facility where each bag is monitored to determine its category and ensure that the appropriate management route is used; so far, 70% has been managed as conventional waste and 30% as VLLW.

B.265. Remediation and validation surveys are complete for 25% of the site, and the remaining work is scheduled to support applications to remove regulatory controls in 2021.

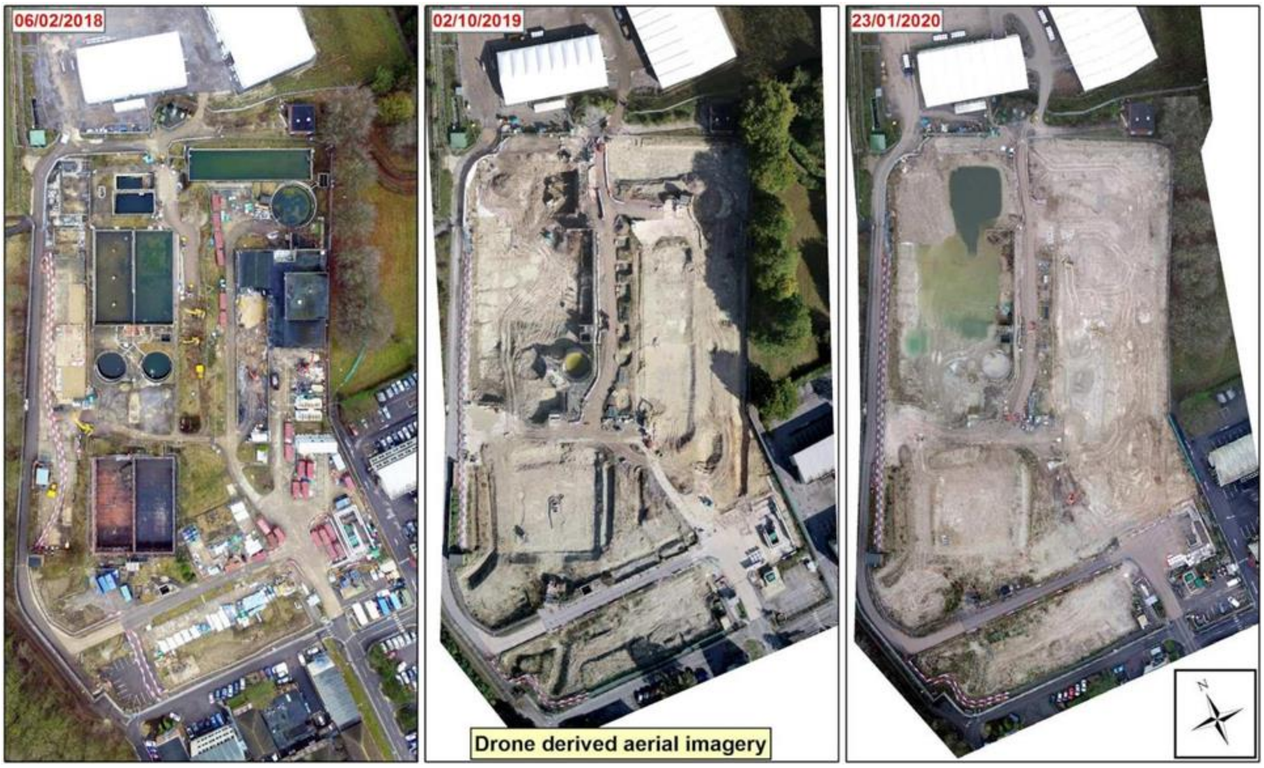


Figure 54: Progressive land remediation at Harwell

Other sites

Decommissioning of Plutonium Contaminated Legacy Bunkers at the LLWR

B.266. Implementing a rigorous operational management regime has enabled LLWR Ltd to overcome significant operational and safety related challenges to decommission a range of contaminated structures several years ahead of programme resulting in £20 million in savings and no lost time safety incidents.

B.267. During the late 1950s/60s Plutonium Contaminated Material (PCM) in drums and crates from various nuclear sites across the UK was brought to the LLWR for storage in reinforced concrete bunkers (known as ‘Magazines’). These structures were originally constructed in the 1940s to store munitions; and, once filled with PCM, were closed and sealed. In the 1990s five Magazine Retrievals Facilities (MRFs) were constructed to create a controlled environment for air-fed-suit entries allowing operators to characterise, size reduce and repackage the miscellaneous PCM so that it could be moved from the site and transported to Sellafield for longer-term safe storage.

B.268. In 2013 a decommissioning project was initiated for final clean-up of the Magazines and MRFs. Although most of the stored material had been removed, the Magazine structures remained highly contaminated and some legacy miscellaneous waste items remained. The programme was planned to take 10 years and cost £100 million.

B.269. The operators were subject to significant radiological and conventional hazards. Their tasks involved decontaminating and size reducing structures and surfaces with >10,000 counts per second alpha; and cutting and lifting over two hundred 300kg concrete sections; often working in very confined spaces. The work proved a challenge to control and supervise; with operators active on multiple work-fronts within up to four Magazines. The radiological conditions required operators to wear full air-fed suits for the majority of the programme duration. Over the 6-year period more than 11,500 entries were made (> 400,000 operator hours); all of which were carried out without an incident leading to any operator taking time off work.

B.270. This work demanded extremely vigilant, systematic safety management on a daily basis. Prior to commencing work each day the entire operations team attended a meeting, to ensure the team were prepared to safely deliver the work planned for that day. At the end of each day the team held a post-job-briefing to review the work and identify any learning. Finally there was a planning meeting held with key operational staff to look forward to the following day's work. Before any operations could commence daily checks were completed to confirm the MRF was safe to access. Each of the decommissioning operators underwent a rigorous training regime before they were deemed to be suitably qualified and experienced to execute the work.

B.271. Through the careful conduct of operations, the dedicated, skilled workforce delivered the PCM Decommissioning Programme 3.75 years ahead of schedule, making savings of approximately £20 million against the original forecast.

B.272. The Magazines are now radiologically clean and the MRF buildings have been dismantled. In the longer term the Magazines themselves will be demolished. The waste arising from the demolition process will be recycled or reused as far as practicable: metal from the retrieval facilities is being recycled and the rubble from the Magazines will be reused on the site to cap one of the LLW disposal vaults. A short 3-minute video on this work is available at the following link: https://www.youtube.com/watch?v=SehBMvyuIVE.

Knowledge / information management

B.273. The vital importance of knowledge and information management to maintaining nuclear safety and environmental protection is recognised.

B.274. Information on facilities and waste inventories must be maintained over many decades to support future safe decommissioning, final site clearance and spent-fuel waste management activities, including where they are expected to be consigned for disposal in a GDF or other disposal facility. The NDA has an Information Governance Strategy to promote the efficient management and re-use of NDA information assets [40]. This will ensure these records are managed appropriately and preserved into the future.

Nucleus: The Nuclear and Caithness Archives

Figure 56: Nucleus and Caithness Archives

B.275. NDA has established Nucleus, as a national archive to preserve relevant nuclear records and information for future activities (Figure 28). Nucleus is a dedicated facility built to store the records related to the facilities on the NDA's nuclear estate. Nucleus will provide a consolidated and secure store for these records, ensuring they remain accessible for potentially hundreds of years in line with legislation and relevant regulations. These records will provide a vital resource for industry, particular to provide information relevant for decommissioning redundant facilities and to manage waste inventory, for instance in relation to consigning it to the GDF. The archive is operated under contract with the NDA subsidiary NDA Archives Limited.

B.276. Nucleus will store a vast number of civil nuclear records, plans, plant designs, research documents, photographs, drawings and other information. For example, records from Dounreay already transferred to the archive amounted to almost a third of a million photographs and 200 te of documents, and Sellafield is estimated to hold more than 80,000 boxes of archived records. The digital archive comprises 30 million records dating back to the late 1940s.

B.277. The process of transferring records from NDA sites to the archive is underway, in a programme expected to take at least five years to complete. In the longer term, most of the hard-copy information is expected to be digitised and made available online to the nuclear industry and other stakeholders (subject to appropriate security restrictions).

Maintaining information on radioactive wastes to be consigned for disposal in a GDF or other disposal facilities

B.278. The importance of collecting and retaining adequate information on radioactive waste being considered for disposal has been identified as important. This is for a number of reasons including, to maintain sufficient knowledge of the potential hazards associated with the facility to allow future generations to make informed decisions concerning the safety of the facility and to avoid potential human intrusion. The bodies operating operational disposal facilities (LLWR Ltd and DSRL) and a future GDF have well developed requirements for waste package records, which detail the contents of individual waste packages and the waste containers used. The waste records requirements for HAW expected to be disposed to a GDF and for LLW disposed at the LLWR are described below.

HAW Package Records

B.279. As described above, HAW (including spent fuel if it deemed to be waste in the future) will be disposed of in a GDF. The LoC issued by RWM for specific waste streams, and its underpinning documentation (including technical assessments) provides the record that a conditioned waste stream is compatible with the GDF. RWM also requires appropriate records to be made to demonstrate that waste packages have been created in compliance with the LoC.

B.280. RWM supports organisations that need to package radioactive waste now for future geological disposal. RWM assesses the compatibility of waste packaging proposals with packaging specifications and the arrangements for producing and maintaining appropriate records [29]. This approach seeks to build and maintain confidence that waste packages will be compatible with the requirements for geological disposal without the need for future rework or repacking.

B.281. The approach adopted recognises that a disposable waste package includes both the physical package, produced and maintained in accordance with the relevant specification, and corresponding package records. Waste package records will ultimately be required to demonstrate that packages meet the acceptance criteria for a GDF, as well as fulfilling all other requirements that might also apply. Examples include demonstration of compliance with requirements for interim storage, nuclear material accountancy and consignment for transport either to off-site storage or a GDF.

B.282. There is a wide range of data and information associated with waste packages that have already been produced and are stored awaiting disposal. These are held in differing formats in diverse locations on sites, together with a similarly diverse and dispersed range of supporting information and documents. Over time workforce changes also presents a risk to the long-term retention of critical knowledge. Recognising these challenge the NDA tasked RWM to develop, maintain and implement an estate-wide waste package assurance programme that will identify and better manage the risk posed by the loss of information needed to demonstrate waste packages can be safely transported and accepted for geological disposal.

B.283. A brief description is now given as to how RWM are working (via a Package Records Project) to fulfil this requirement. The RWM Package Records project has provided a specific definition of what constitutes a package record and has been working closely with UK waste packagers to apply this to both the 70,000 existing HAW packages in the NDA estate as well as to new waste packages produced. The project incorporates lessons learned from implementing waste disposal at the LLWR.

B.284. The RWM Records Project started in 2015 with a programme to produce the underpinning specification and guidance and to produce a Waste Package Records (WPR) approval process for implementation in April 2017. Subsequently, a target was agreed that all historic waste package records (i.e. ILW packages currently in interim ILW stores) will have an approved waste package record by March 2021. All new ILW packages should also have an approved waste package record within 12 months of entering interim ILW stores. What constitutes a waste package record is shown in Figure 29.

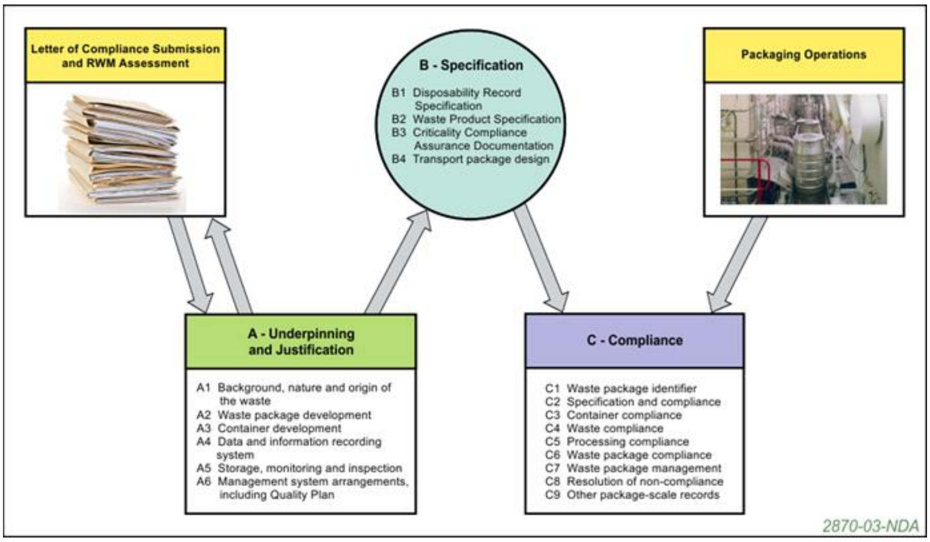


Figure 58: RWM Waste Package Records

Low Level Waste package records

B.285. Information about the repository contents are compiled in the form of a waste package record (or final consignment record) which details the contents of individual waste packages. This constitutes information on the physical, chemical and radiological properties of the waste within the package, as well as information relating to the waste container. The information and data recorded covers the entire waste lifecycle from the time of arising, through initial waste characterisation, waste treatment (including production of any secondary wastes), waste-package development, to package production, storage, transport and disposal at the LLWR. LLWR Ltd requires that waste consignors use all reasonable endeavours to acquire and record sufficient data and information to inform the final waste package record prior to shipment to the repository.

B.286. The records are produced by waste consigners and agreed with LLWR Ltd to demonstrate that the waste complies with the repository Waste Acceptance Criteria, through the LLWR Waste Acceptance Process.

B.287. In order to comply with its environmental permit, the LLWR Ltd is required to keep all records on its premises, unless otherwise agreed by the Environment Agency. The individual documents that form a final waste package record for waste disposed at the LLWR are stored on LLWR Ltd's electronic records system; and a copy of each complete waste package record for consignments will be sent to the NDA Archive in Caithness, to ensure that relevant records remain secure and accessible in accordance with legislation and relevant regulations.

Maintaining information on sites in Care and Maintenance

B.288. As mentioned earlier, the Bradwell site is now in an extended period of C&M until final site clearance in around 70 years' time. To preserve relevant information that will be needed to maintain the site during C&M and to inform the final site clearance operations, Magnox Ltd developed the Knowledge Information Data Library (KIDL) (Figure 30). This is a database which includes a wide range of information, including waste inventory and areas of contamination remaining on site, design and engineering documentation on remaining structures and the safety case for the C&M state, required to maintain the site in a safe state, compliant with legal requirements and to preserve the information that will be required in the future. KIDL provides a model system that is likely to be used for any other Magnox Ltd sites put into C&M.

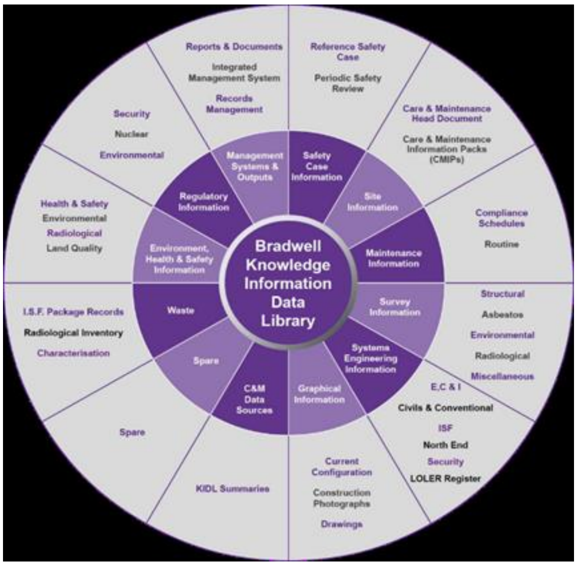


Figure 60: The Bradwell Knowledge Information Data Library (KIDL)

Innovation

B.289. The UK government is committed to maximising the benefit of innovation for economic growth in the UK. The UK Industrial Strategy [41] presents an approach on how businesses can be supported to improve productivity and shape a stronger, fairer economy. The strategy is built upon five foundations: Ideas; People; Infrastructure; Business environment; and Places (Figure 31), which align with the vision for a transformed economy.

B.290. The commitment to innovation is a key element of the Industrial Strategy. Innovate UK, a non-departmental public body, has been established to work with people, companies and partner organisations to find and support the innovations that will drive future economic growth.

B.291. Innovation has always been a significant feature of the UK civil nuclear sector and is recognised as crucial to meeting the challenges faced by the industry. The UK government's Nuclear Sector Deal (NSD) [42] continues this as a commitment by the nuclear sector to work collectively, with support from UK government, to deliver on the Industrial Strategy and encourage innovation-led growth that delivers lower costs for new build nuclear electricity generation and a 20 per cent reduction in the costs of decommissioning and waste management. This is supported by national initiatives such as the Nuclear Innovation Programme [43], which fund research in areas such as advanced nuclear fuels/reactors and manufacturing technologies. Such support and investment in innovative new technologies is aimed at positioning the UK at the forefront of the nuclear technologies of the future.

Figure 62: UK Industrial strategy- Five foundations of productivity

B.292. This commitment to innovation is promulgated through the NDA strategy [9], through activities such as funding nuclear R&D and development and utilisation of novel technologies and techniques to address the challenges in decommissioning and radioactive waste management and optimise these activities across the NDA estate.

B.293. The regulatory bodies also have a key role to play in supporting the use of innovation to the extent that it is within their remit and influence and in compliance with relevant laws. The regulators must be flexible when assessing the use of novel techniques or approaches to deliver its benefits, in areas such as the safe management of spent fuel and radioactive waste.

B.294. The UK's regulatory regime is non-prescriptive and can be characterised as goal-setting and is therefore well suited to supporting innovation across the industry and supply chain. The regulatory regime is technology neutral and does not seek to prescribe design solutions, rather it is focussed more on outcomes than processes and provides flexibility around technological advancements and use of new methods and approaches only requiring that they are appropriately justified and the risks are managed appropriately.

B.295. The enabling approach to regulation adopted by the UK regulators reduces barriers to the use of innovative approaches and provides appropriate levels of flexibility and proportionality in consideration of risks associated with activities. This approach emphasises the value of early dialogue for operators to receive regulatory advice related to the design of innovative solutions to give them a better understanding of regulatory expectations on what is required to demonstrate safety, reducing uncertainties and costs, and increasing the chances of successfully deploying new approaches.

B.296. In 2018 ONR published a booklet on Enabling Regulation in Practice [44]. This reflects many of the same principles embedded in the regulatory ways of working of the EA, for example as set out in 'Regulating for people, the environment and growth, 2018' [45]. The experiences of the ONR and environment agencies in providing an enabling regulatory environment has been shared with government, regulators and representatives of other high-hazard industries so to help explore further the challenges and opportunities of driving innovation to build positive economic impact. Nine key principles were agreed that provide a blueprint for action through cooperation with government, industry and regulators; these are presented in the report of a workshop entitled: 'Cross industry decommissioning – innovation & regulation workshop, 3 May 2019' [46].

B.297. The UK government has established a framework and funding mechanisms to provide an environment to stimulate research and innovation to drive productivity and economic growth by supporting businesses to develop and realise the potential of new ideas to address key issues and challenges. The UK Research and Innovation (UKRI), sponsored by BEIS, is a national funding agency that works in partnership with UK research councils, universities, government and businesses and other bodies, to ensure research and innovation continues to flourish in the UK.

B.298. As part of UKRI, Innovate UK funds business and research collaborations to accelerate innovation and business growth, and drive business investment into R&D. Innovate UK funds work across all sectors of the economy and industry, including the nuclear sector. Access to funding is typically through competition, where solution providers are invited to bid to provide a solution for a defined objective. Such a competition, 'integrated innovation for nuclear decommissioning', funded by Innovate UK, NDA and BEIS, was held to identify innovative ways to minimise human intervention, increase productivity and optimise waste treatment, packing and routing. A short video showcasing the competition is available at the following link: www.youtube.com/watch?v=Klb6YKJGq7I. The active demonstration of the successful projects is currently being planned at Sellafield.

B.299. A successful project was a decommissioning system for carrying out decommissioning work in typical nuclear environments such as shielded caves. The system integrates technologies to characterise and visualise an environment, plan and carry out tasks such as size reduction, sludge removal, decontamination and control and mitigate airborne contamination and mange resultant wastes. A ten minute video on this technology is available at the following link: www.youtube.com/watch?v=cuNDO8Gmuic.

Game Changers initiative

B.300. "Game Changers" is an innovation programme focussed on identifying and developing cutting-edge technologies that may deliver significant advances and cost savings in the decommissioning of the Sellafield site. The programme is funded by Sellafield and co-delivered by the National Nuclear Laboratory (NNL) and FIS360 (specialists in supporting early stage technologies from concept to commercial product).

B.301. Working closely with Sellafield personnel, the Game Changers team define and publicise challenges which are then opened up for technology providers to offer viable solutions.

B.302. Feasible solutions receive funding to develop ideas and concepts with feasibility and proof of concept grants available. Successful providers are supported by the Game Changers team to ensure their ideas are best developed to meet Sellafield's needs and, where possible, to optimise the move to full implementation across the Sellafield site and other nuclear sites.

B.303. Game Changers innovation has focussed on a wide range of decommissioning themes including:

- Waste management and storage;
- Condition Monitoring and Inspection (CM&I) of waste packages in storage;
- Post Operational Clean Out;
- Robotics and Artificial Intelligence; and
- Analytical services

B.304. It has supported 109 feasibility projects and progressed 26 of these to proof of concept stage.

B.305. Some example Game Changer projects of particular relevance to the management of spent fuel and radioactive waste are:

- Remote detection of hydrogen: To be used as part of CM&I to monitor hydrogen released from radioactive waste packages in stores to support safe storage;
- Immobilisation of sludge wastes in ceramics: To encapsulate radioactive waste into a passively safe immobile form for safe storage; and
- Detecting early signs of waste container corrosion: Using hyperspectral imaging as part of CM&I to remotely detect early signs of corrosion of radioactive waste containers.

B.306. There are many examples where innovation has been used in the UK nuclear industry to facilitate progress and address challenges in spent fuel and radioactive waste management. Some examples and case studies are presented below.

- The regulatory strategy developed to influence accelerated hazard and risk reduction at Sellafield legacy ponds and silos facilitated significant progress on the remediation of these high hazard legacy facilities. The strategy underpinned the use of the 'decommissioning mind-set' to develop fit for purpose solutions with pragmatic and proportionate consideration of risk and risk appetite, and formation of the G6 group to maintain focus on priority outcomes and removal of unnecessary bureaucracy, blockers and distractions to making timely progress;

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  LaserSnake technology [47], developed with R&D funding from the NDA, is a long, flexible robotic arm with a purpose-designed laser cutting head, capable of cutting metal up to 100mm thick, which is operated remotely. The arm is highly flexible, enabling it to gain access to difficult-to-access areas of nuclear facilities, often through small penetrations, that would be difficult, if not impossible to be carried out directly by workers. It is cheaper, faster and safer than conventional cutting techniques, and produces less secondary waste.

  

  LaserSnake has been used successfully at Sellafield to size reduce a 5 tonne, double-walled stainless-steel vessel. It was also used in what was thought to be the first use of laser cutting in a reactor core to reduce the size of parts of the Dragon reactor core at Winfrith. A short 2-minute video is available at the following link: http://www.youtube.com/watch?v=MKNRLf1vaM4&feature=youtu.be;

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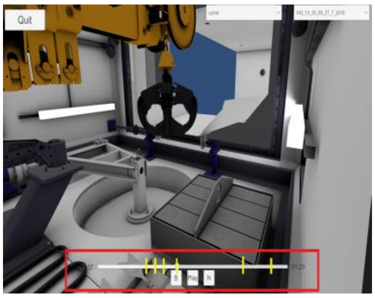
  NDA has adopted the extensive use of aerial drones in decommissioning [48]. Across the NDA estate, a variety of drones have been flown to carry out a range of different tasks, including carrying out inspections of legacy facilities, using visual cameras and other sensors to map their condition, temperature and radioactivity. The use of drones reduces risks to workers by reducing the need for working at height and potential radiation doses, as well as saving time and money. Cost savings through the use of drones at Dounreay are estimated to be £100,000 [49].

- Sellafield is innovating the use of ROVs in work in legacy ponds and silos. From initial use carrying out visual and radiological surveys, the application of ROVs has been extended to a much wider range of tasks, including physical manipulation of pond items such as moving spent fuel elements and furniture and operation of sludge removal equipment. This has resulted in accelerated progress in decommissioning and clean-up activities and substantial reductions in worker doses. A 6-minute video showing the use of ROVs at Sellafield is available at the following link: https://www.youtube.com/watch?v=S-YDBN1jDq8.

- Sellafield is making increasing use of Virtual Reality (VR) and Mixed Reality to aid in design, development, operational planning and operator training. For example, SL, in collaboration with the University of Liverpool's Virtual Engineering Centre, has developed a state-of-the-art mixed-reality simulator that replicates the PFCS waste retrievals equipment and operator working environment (including replicas of the equipment's control joysticks, with haptic feedback, and virtual camera views), to provide a fully immersive and realistic operator training environment.

  This is being used to support operators through a comprehensive training programme to develop the levels of skill needed to carry out waste retrievals. The use of this simulator has already been shown to increase efficiency and productivity, for instance by allowing operators to determine the best places to put visual reference aids in the real retrievals equipment, to help them position the crane more precisely and to refine and optimise the waste retrievals process.



- The NDA has actively engaged with other industries (such as oil and gas) to share learning and best practice, swap tools and techniques and build a cross-industry supply chain to help facilitate decommissioning work and reduce costs. Many of the innovative decommissioning approaches that have been used on UK nuclear sites to expedite clean-up and hazard reduction work, including the use of robotics, ROVs and scanning technology, have built upon the use of these technologies in other industries. As part of this, the NDA has facilitated a series of cross-industry learning workshops with a wide range of industries, academics and regulators to share experience. An overview of these is available in an NDA report entitled: 'Decommissioning Learnings: Sharing good practice across industrial sectors' [50].

Section C – Scope of Application

Article 3:

1. This Convention shall apply to the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors. Spent fuel held at reprocessing facilities, as part of a reprocessing activity, is not covered in the scope of this Convention unless the Contracting Party declares reprocessing to be part of spent fuel management.
2. This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.
3. This Convention shall not apply to the safety of management of spent fuel or radioactive waste within military or defence programmes, unless declared as spent fuel or radioactive waste for the purposes of this Convention by the Contracting Party. However, this Convention shall apply to the safety of management of spent fuel and radioactive waste from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes.
4. This Convention shall also apply to discharges as provided for in Articles 4, 7, 11, 14, 24 and 26.

C.1. The scope of application of the JC in the UK remains unchanged since the sixth UK NR. The scope is reiterated below.

Spent fuel management and reprocessing

C.2. This report covers the safety of spent fuel arising from the operation of civilian nuclear reactors. As established since the adoption of the JC, the UK considers reprocessing of spent fuel to be an integral part of spent fuel management. As such, this report covers the safety of spent fuel reprocessing facilities, including the storage of spent fuel at such facilities where it takes place as part of the reprocessing activity.

C.3. The report covers the Magnox Reprocessing Plant and THORP at Sellafield. During the period covered by this report, THORP has ceased operations, moving into a POCO phase, and the Magnox Reprocessing Plant remains operational and is scheduled to complete its reprocessing operations in 2020/21. Following cessation of all reprocessing activities, spent fuel will be put into interim storage pending a future decision on disposition. Until such a decision is made, spent fuel is not considered to be radioactive waste by the UK government. It is however included within GDF planning.

Radioactive waste management

C.4. This report covers the safety of radioactive waste management for radioactive waste arising from civilian applications. This predominantly arises from the nuclear fuel cycle and disused sealed sources, but also includes relatively small volumes of mostly LLW arising from other sectors (such as hospitals, research and development establishments and other non-nuclear industries).

C.5. This report does not consider NORM to be radioactive waste for the purposes of the JC. However, NORM may be considered as radioactive waste in future UK NRs.

C.6. The report also covers discharges and disposals of radioactive waste to the environment.

Section D - Inventories and Lists

Article 32.2: This report shall also include:

i) a list of the spent fuel management facilities subject to this Convention, their location, main purpose and essential features;

ii) an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity;

iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;

iv) an inventory of radioactive waste that is subject to this Convention that:

a) is being held in storage at radioactive waste management and nuclear fuel cycle facilities;

b) has been disposed of; or

c) has resulted from past practices.

This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides;

v) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.

D.1. The arrangements to comply with this Article have not changed substantially since the sixth UK NR.

D.2. The UK maintains the UKRWI [25], which provides the latest national record on radioactive wastes and materials; it contains information about:

- Radioactive wastes that exist now;
- Radioactive wastes that will arise in future; and
- Radioactive materials – radioactive items that are not classed as waste now but may be in the future if no further use can be found for them.

D.3. This inventory provides a snapshot of wastes and materials at a specific point in time, called the ‘stock date’. This is updated every three years, with the last updated being as of 1 April 2019 (Table 1).

Table 1: UK radioactive waste inventory and estimates of future accumulations by waste category (as of 1 April 2019)

Waste category	Volume (m^3)		
	Reported at 1 April 2019	Estimated future arisings	Lifetime Total
HLW	2,150	-760(1)	1,390
ILW	102,000	145,000	247,000
LLW	27,400	1,450,000	1,480,000
VLLW	1,040	2,830,000	2,830,000
Total	**133,000**	**4,420,000**	**4,560,000**

(1) The negative figure is due to an estimated net decrease in the quantity of HLW after the stock date due to accumulated High Activity Liquor (HAL) being conditioned (which reduces its volume by around two-thirds), and due to some HLW being returned to overseas customers.

D.4. Table 2 below provides a summary of the UK spent fuel inventory and estimates of future accumulations (more detail is provided in Table 17). All spent fuel is either in reactor or in storage. No spent fuel (should it be declared as waste) will be disposed of until a GDF becomes available.

Table 2: UK-owned spent fuel inventory (as of 1 April 2019) and estimated future arisings

Spent fuel type	Inventory (tonne)		Estimated future accumulations (tonne)
	In reactor core	In storage (out of reactor core)	
Magnox	149	625	-
AGR	1500	2200	~1800
PWR	~90	~530	~430
'Exotics'	~21	3	-
Other	-	1	-

D.5. The additional requirements specified in Article 32.2 are provided in Section L.2 – Lists and Inventories:

- List of spent fuel management facilities and Inventory of spent fuel;
- List of radioactive waste facilities and inventory of radioactive waste;
- List of nuclear facilities in the process of being decommissioned.

Section E – Legislative and Regulatory System

E.1. The UK has a mature, well developed legislative and regulatory system to ensure the safe management of spent fuel and radioactive waste. This has been presented in detail in Section E of previous UK NRs. To improve the focus of this section, it now provides only a high level overview of the legislative and regulatory system, sufficient to demonstrate how the UK complies with Articles 18-20 of the JC. Section B - Policies and Practices provides complementary information, describing the application of the legal and regulatory system in practice.

E.2. This section also describes significant changes to the legislation and regulatory system that have been implemented since the sixth UK NR. These are:

- Introduction of the Ionising Radiations Regulations 2017 and the Ionising Radiations Regulations (Northern Ireland) 2017 – replacing the 1999 regulations;
- Updates to the Environmental Permitting (England and Wales) Regulations 2016 - amended in 2018;
- Introduction of the Environmental Authorisations (Scotland) Regulations 2018, which provide an integrated authorisation framework for radioactive substances in Scotland;
- Introduction of the Radiation (Emergency Preparedness and Public Information) Regulations 2019 (replacing REPPIR2001) covering preparedness and response to radiation emergencies, along with an ACoP;
- Amendments to the Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations, to bring it in line with its parent EU directive; and
- Development to prepare for legislative changes in relation to licensing a GDF.

Implementing Measures (Article 18)

Article 18: Each Contracting Party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.

E.3. The measures for implementing the obligations under the JC are provided through the UK's comprehensive legal framework. The general features of this framework are presented in this section, with the specific legislation relating to the safety of spent fuel and radioactive management being described below under Article 19.

E.4. In the UK, there is devolution of powers in specific policy areas from the UK Government to the Scottish Government, the Welsh Government and the Northern Ireland Executive (referred to collectively as the 'devolved administrations'). 'Devolved powers' are those which have been passed from the UK Parliament to one of the devolved administrations and 'Reserved powers' are those that remain with the UK Parliament (some policy areas may be devolved to one (or more) of the devolved administrations but reserved in others). Where powers are devolved, laws in that area are made by the Scottish Parliament, National Assembly for Wales or Northern Ireland Assembly, as appropriate, rather than by the UK Parliament. Devolution in the UK is described in more detail in a document entitled: 'Introduction to devolution' [51].

E.5. The UK government retains responsibility for legislation relating to nuclear safety, energy and security. The UK government is also responsible for radioactive waste management and environmental protection in England. The devolved administrations each retain responsibilities for legislation relating to radioactive waste management and environmental protection in their respective nations. This is summarised in Figure 32 below.

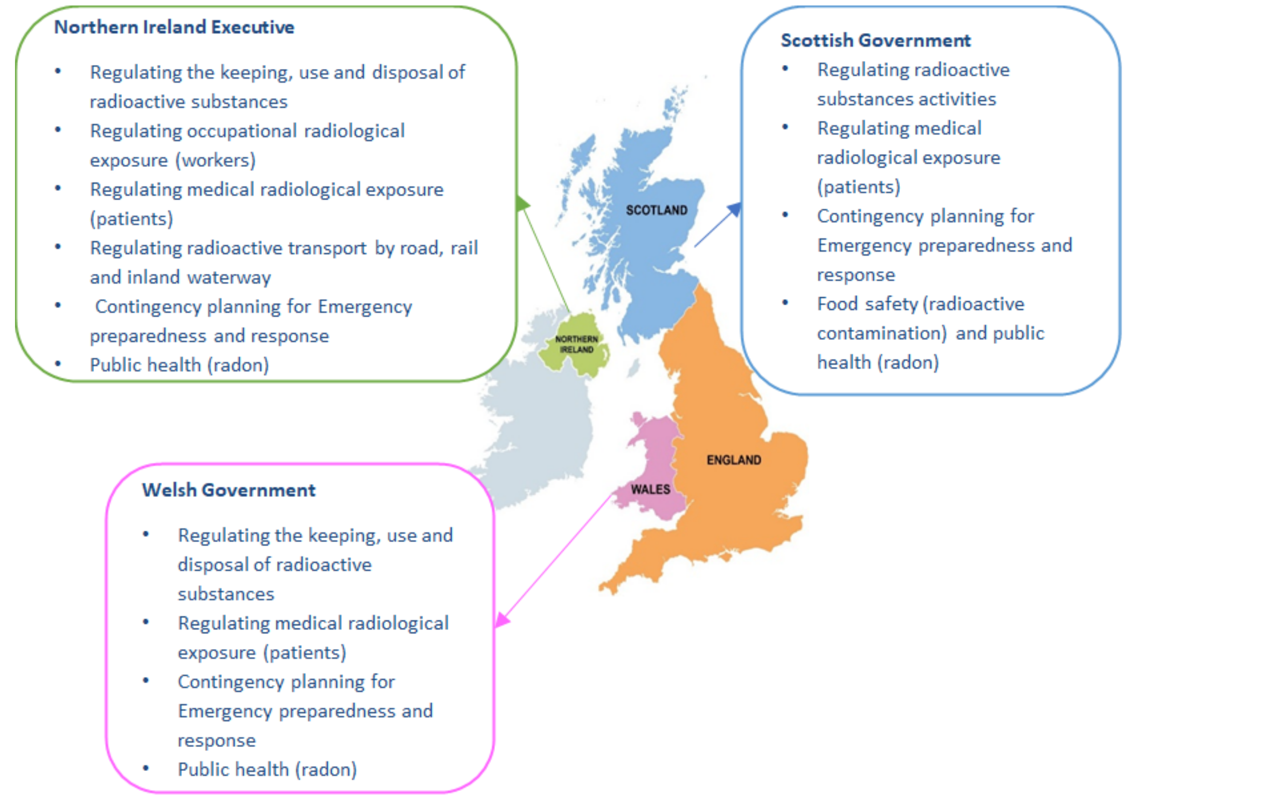


Figure 64: Devolved administrations of the UK and their devolved powers

E.6. ‘Secondary legislation’ (also known as ‘subordinate legislation’) is delegated legislation that is created by government ministers (or other bodies such as public bodies) under the authority contained in primary legislation. The main types of secondary legislation are Statutory Instruments (SI), Statutory Rules and Orders. There is primary and secondary legislation that implements the UK’s obligations under the JC (indicated as appropriate under Article 19 below). There is no legal hierarchy between primary and secondary legislation as all of the legislation applies without discrimination as to its origin.

E.7. During the UK’s membership of the EU and Euratom, the requirements of European Directives have been incorporated into UK law and certain European regulations had direct effect in the UK. At the end of the transition period, this will no longer be the case, with the exception of Northern Ireland under the Northern Ireland Protocol. Existing UK legislation that implemented EC legislation will remain unchanged by EU exit, save for amendments to ensure the legislation continues to be operable. However, any future changes to legislation will be under sovereign control, and independent of any changes in EU law, with the exception of Northern Ireland which will remain aligned with specific EU legislation. The UK remains committed to keeping its legal and regulatory framework under review to ensure that it takes account of developments in internationally endorsed safety and environmental protection standards.

E.8. The withdrawal from the EU and the Euratom Treaty will have no major impact with regards to compliance with the obligations of the JC. Work is underway to ensure an internationally endorsed and effective regime is maintained in areas of cooperation such as research, notification, information sharing and transboundary movement of spent fuel and radioactive waste.

E.9. The legislation pertaining to the management of spent fuel and radioactive waste management sets out clear legal requirements and establishes the scope of the legal authority of the various regulatory bodies. The vast majority of the spent fuel and radioactive waste is produced on the 36 licensed nuclear sites (including operating nuclear power stations and other nuclear facilities; as listed in Section L.2 – Lists and Inventories). NIA65 enables ONR to grant nuclear sites licences, and attach conditions to them, which are aimed at securing the safety of operations, including the handling, treatment and disposal of spent fuel and radioactive waste. Only a corporate body, such as a registered company or a public body can hold a licence and the licence is not transferable. ONR is the authority that grants, enforces, varies and revokes nuclear site licences and provides guidance on the process in the document entitled 'Licensing Nuclear Installations' [52]. The standard 36 Licence Conditions (LC) [53] attached to a nuclear site licence provides ONR with legal powers to control activities and give its permission to activities where they are deemed to be safety significant. The LCs are non-prescriptive and set goals for which the licensee is responsible for meeting, amongst other things by applying relevant safety standards and safe procedures. As well as placing requirements on the licensee, the standard 36 LCs also include requirements for regulatory interactions between ONR and the licensees. The six primary powers conferred through the LC include the ability to:

- Issue Directions to require an action to be taken;
- Give discretionary controls with regards to a licensee's arrangements, these are implemented through specifications;
- Request the submission of information by notifying the licensee of the requirement;
- Consent to allow activities to proceed when formally specified;
- Approve licensee's arrangements so they can't be changed without subsequent approval; and
- To indicate an agreement issued by ONR allowing a licensee, in accordance with its own arrangements, to proceed with an agreed course of action.

E.10. The bulk of radioactive wastes produced from nuclear sites, and those produced from non-nuclear activities, are disposed in facilities at non-licensed sites. Such activities are regulated in accordance with the environmental legislation, EPR16 in England and Wales, EASR18 in Scotland and RSA93 in Northern Ireland. Each of these require that a permit or authorisation is obtained from the relevant environmental regulator for radioactive discharges (whether from a nuclear or non-nuclear activity) and disposals of radioactive waste.

E.11. A key feature of the UK nuclear regulatory regime for safety is that it is largely non-prescriptive and goal-setting in nature and the responsibility for safety and environmental protection rests solely with the duty holder. The Health and Safety at Work etc Act 1974 (HSWA74), a principal law for the safety of workers and the general public, requires that for any undertaking the work is carried out in a way that ensures that risks to affected persons are reduced 'so far as is reasonably practicable' (SFAIRP) (usually expressed as reducing risks to be ALARP).

E.12. On a licensed nuclear site, the responsibility for reducing risks to ALARP and environmental protection rests solely with the licensee. This is expected to be achieved by applying relevant safety standards and safe and compliant procedures. ONR ensures that licensees are compliant with their legal obligations through inspection and enforcement and by technical assessments of safety cases or submissions. ONR's judgement is guided by reference to its Safety Assessment Principles (SAPs) [54] and associated Technical Assessment Guides (TAGs) [55], UK Approved Codes of Practice (ACoPs) (which provide approved guidance on how to achieve compliance) and other authoritative standards or guidance.

E.13. For environmental protection, operators demonstrate that exposures are as low as reasonably achievable (ALARA) through the use of best practicable means (BPM) and best practicable environment option (BPEO) in Scotland and Northern Ireland; and in England and Wales, use of best available techniques (BAT), which is broadly equivalent to a combination of BPM and BPEO. The key principle is to require those that create the risk to demonstrate that they have done everything reasonably practicable to reduce risks, balancing the level of risk created by their activities against the measures needed to control that risk whether in money, time or resources.

E.14. The UK government's Regulators' Code [56] provides a framework of how UK regulators should engage with those they regulate. The Code promotes that regulators are proportionate, consistent and targeted in their regulatory activity and transparent and open in engagement with those they regulate. The regulators each embody this approach as an 'enabling regulator', holding licensees to account but taking a constructive approach with operators to enable effective and timely delivery against clear and prioritised safety and security outcomes and to influence improvements. The ONR approach to being an enabling regulator is presented in the document entitled 'Holding industry to account and influencing improvement – A guide to enabling regulation in practice' [44]; and the EA approach in the document entitled 'Regulating for people, the environment and growth, 2018' [45].

E.15. The regulatory bodies each have defined legal powers and responsibilities and work together closely where there are areas of mutual interest. This is formalised through several Memoranda of Understanding (MoU) between ONR, EA, SEPA and NRW, which have been adopted to ensure appropriate cooperation and coordination between these regulatory bodies to help achieve common goals in relation to delivering efficient and effective regulation to secure the highest levels of safety and environmental protection. In line with the MoUs, ONR and the environment agencies routinely work closely and sometimes conduct joint inspections in areas with common interest. There is also joint regulatory guidance on the management of HAW on nuclear licensed sites [6], which presents what is regarded as relevant good practice to achieve compliance with the relevant legal requirements. Similarly, recognising the potential confusion that devolved arrangements could introduce, the environment agencies work closely to develop, where possible, joint guidance for UK operators (for example, the Guidance on requirements for authorisation of near-surface disposal facilities [57]. BEIS also provide strategic level coordination between UK government, devolved administrations and regulators on the development and delivery of policy, legislation and regulation through various groups, such as the Radioactive Substances Policy Group.

Legislative and Regulatory Framework Governing the Safety of Spent Fuel and Radioactive Waste Management (Article 19)

Article 19:

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.
2. This legislative and regulatory framework shall provide for:
   - (i) the establishment of applicable national safety requirements and regulations for radiation safety;
   - (ii) a system of licensing of spent fuel and radioactive waste management activities;
   - (iii) a system of prohibition of the operation of a spent fuel or radioactive waste management facility without a licence;
   - (iv) a system of appropriate institutional control, regulatory inspection and documentation and reporting;
   - (v) the enforcement of applicable regulations and of the terms of the licences;
   - (vi) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management.
3. When considering whether to regulate radioactive materials as radioactive waste, Contracting Parties shall take due account of the objectives of this Convention.

Legislative and regulatory framework (Article 19.1 and 2)

E.16. The legislative and regulatory framework covering the safety of spent fuel and radioactive waste on nuclear and non-nuclear sites and providing compliance with the obligations of the JC is comprehensive and well established. As this framework is substantively unchanged from that presented in the sixth UK NR, only an overview and any significant updates are presented in this section.

National safety requirements and regulations for radiation safety and licensing activities (Article 19.2(i), (ii) and (iii))

E.17. The safety requirements for radiation safety (including the safe management of spent fuel and radioactive waste) and environmental protection on nuclear and non-nuclear sites are provided by legal instruments covering:

- General health and safety of workers and the public;
- Nuclear safety on licensed nuclear sites;
- Environmental protection on licensed nuclear sites and non-nuclear sites;
- Radiation protection on licensed nuclear sites and non-nuclear sites;
- Management of radioactive sources;
- Decommissioning/dismantling of nuclear power stations and nuclear reactors; and
- Transport of radioactive material.

E.18. The key legislation is summarised below. The legislation explicitly assigns responsibilities to regulatory bodies, ONR and the environment agencies, as appropriate (see Figure 33 and **Error! Reference source not found.** below for a pictorial representation).

E.19. HSWA74 [58] is primary legislation that applies to all work activities on nuclear and non-nuclear sites in the UK. It provides a requirement that all employers must conduct their activities in such a way as to ensure, so far as is reasonably practicable, the health and safety at work of their employees, and also those affected by their work activities. HSWA74 allows for secondary legislation to be made under it, so called relevant statutory provisions, to cover specific areas, for instance IRR17 for radiation protection, REPPIR19 for radiation emergency preparedness and Management of Health and Safety at Work Regulations 1999 (MHSWR99) which supplements and extends the general duties in HSWA74 and introduces the requirement for employers to carry out risk assessments. HSWA74, together with its statutory provisions, forms the framework of legislation to govern all aspects conventional health and safety and radiation protection.

E.20. On licensed nuclear sites, the management of spent fuel and radioactive waste is subject to a licensing regime for safety and environmental protection (Figure 33). Operators must have an appropriate licence or permit to carry out activities involving spent fuel or radioactive waste.

E.21. NIA65 [59] requires that a nuclear site licence is in force before a site may be used for the purpose of installing or operating any nuclear reactor or any other installation which may be prescribed and stays in force until the site no longer presents any danger from ionising radiation. Such prescribed installations are listed in the Nuclear Installations Regulations 1971 (NIR71) [60] and include nuclear fuel manufacturing and isotope production facilities, fuel reprocessing and bulk storage of certain types of radioactive materials. It is the UK government's policy that a GDF will be a nuclear installation under NIA65. Nuclear sites require a licence under NIA65 from ONR in order to operate. ONR has reviewed its process and guidance for granting a nuclear site licence to new nuclear facilities to ensure they appropriately consider the particular safety and technical aspects pertinent to a GDF [61] and work is underway to establish a legal requirement through amending NIR71 for the GDF developer to obtain a nuclear site licence prior to its construction and operation.

E.22. As mentioned in paragraph E9, ONR is the authority that grants, enforces, varies and revokes nuclear site licences and uses the powers provided through the nuclear site licence and its attached conditions to regulate nuclear safety on nuclear licensed sites.

E.23. The nuclear site licence has 36 standard LCs [53] that require the licence holder to make and implement adequate arrangements to ensure safety, including for the storage and disposal of nuclear matter, including radioactive waste and spent fuel. The LCs are non-prescriptive and set goals for which the licensee is responsible for meeting, amongst other things by applying relevant safety standards and safe procedures.

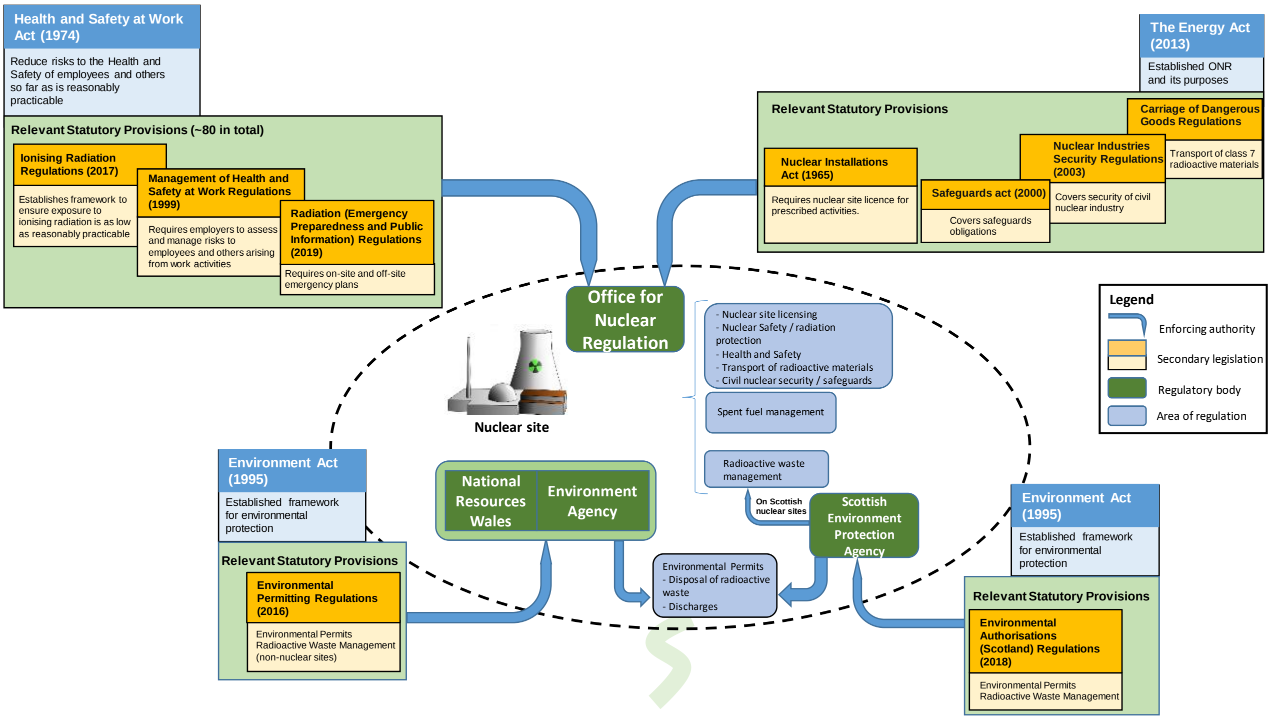


Figure 66: Overview of the UK legislative and regulatory framework and permitting regime for nuclear sites

E.24. Any project to decommission or dismantle a nuclear power station or other nuclear reactor (such as research reactors), requires a Consent from ONR under EIADR [62]. Under EIADR, the operator is required to submit an Environmental Statement (ES) to ONR, which includes a detailed plan for the decommissioning project and an environmental impact assessment, which describes the potential impact of the project on the environment and proposed mitigation measures. The ES must include plans for how radioactive and non-radioactive wastes arising from the decommissioning/dismantling work will be managed. The ES is assessed by ONR, with full consultation of interested parties (such as the relevant environment agency and local authorities) and the public; any European Economic Area (EEA) states on which the project could have an impact must be engaged by UK government. ONR issues a Consent to allow the project to commence and maintains regulatory oversight of the project through to its completion through its site inspection and regulation work.

E.25. As explained above, the devolved administrations implement their own legislation relating to radioactive waste management (including on non-nuclear sites) and environmental protection (**Error! Reference source not found.**):

- Environmental Permitting Regulations 2016 in England and Wales;
- Environmental Authorisations (Scotland) Regulations 2018 in Scotland; and
- Radioactive Substances Act 1993 in Northern Ireland.

E.26. These legislative instruments require prior authorisation through an environmental permit for certain activities with radioactive waste. There are differences in how they apply in relation to nuclear and non-nuclear sites and between devolved countries. In general, an environmental permit is required for disposal of radioactive waste and for discharge of radioactive waste from nuclear and non-nuclear sites. In England and Wales, an environmental permit is required for the use and storage of radioactive waste on non-nuclear sites, with this requirement being exempt for nuclear sites where these activities are regulated under the nuclear site licence by ONR. However, in Scotland, a permit under EASR18 is also required for these activities on nuclear sites as well as on non-nuclear sites. In Northern Ireland, a certification of registration is required for the keeping or use of radioactive substances and a certificate of authorisation for the accumulation and disposal of radioactive waste.

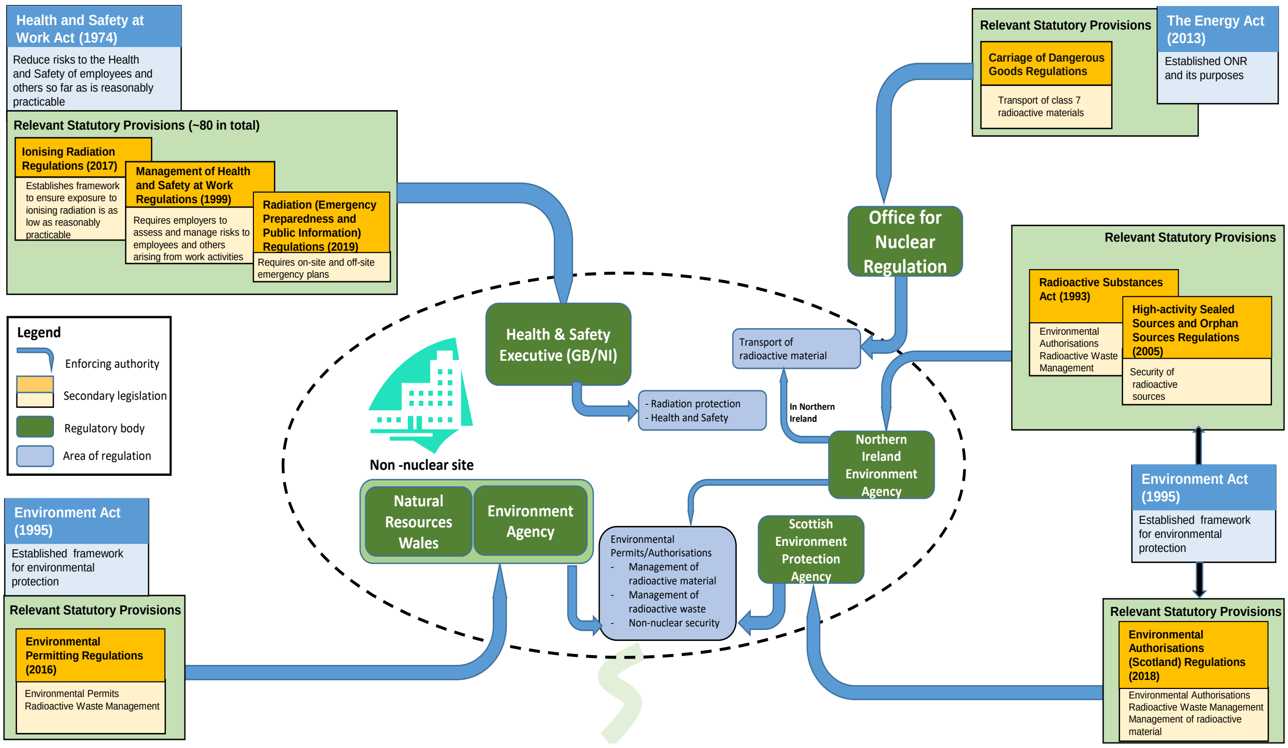


Figure 68: Overview of the UK legislative and regulatory framework and permitting regime for non-nuclear sites

Transportation of radioactive materials

E.27. This section describes the legislative framework for the transportation of radioactive materials including spent fuel and radioactive waste. The obligations within the convention for trans frontier shipment are under Article 27 and are described in Section I – Transboundary Movement of this report.

E.28. The regulation of the transportation of radioactive material, which includes spent fuel and radioactive waste, depends on the mode of transport and in some cases the locations. The regulations require there to be a Competent Authority (CA) and Enforcing Authority, which are appointed within the regulations as described in Table 3.

Table 3: Competent Authorities and Enforcing Authorities for the transport of radioactive material (including spent fuel and radioactive waste)

<table>
<tr><th>Mode of transport</th><th>Great Britain (England, Scotland and Wales</th><th>Northern Ireland</th></tr>
<tr><td>Road</td><td rowspan="3">ONR(1), MOD(2), HSE(3)

In practice, inland waterways are not used for transporting radioactive material in GB.</td><td rowspan="3">The Northern Ireland Environment Agency (NIEA)(4)

Health and Safety Executive Northern Ireland (HSENI) for rail and inland waterways(5).

In practice rail and inland waterways are not used for transporting radioactive material in NI.</td></tr>
<tr><td>Rail</td></tr>
<tr><td>Inland waterway</td></tr>
<tr><td>Sea</td><td colspan="2">Maritime and Coastguard Agency (MCA), an agency of the Department for Transport(6)</td></tr>
<tr><td>Air</td><td colspan="2">Civil Aviation Authority (CAA)(7)</td></tr>
</table>

(1) For the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG09) and IRR17 as they relate to the civil carriage of class 7 goods
(2) For CDG09 in relation to defence
(3) For IRR17 in relation to defence
(4) For the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (Northern Ireland) 2010 as amended (CDG(NI)10) by road
(5) Under IRRNI17 and rail and inland waterway under CDG(NI)10
(6) For Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997
(7) For Air Navigation (Dangerous Goods) Regulations 2002

E.29. The ONR has entered into agency agreements [63] with each of the other CAs, which authorise the ONR to perform some of the functions of the other CAs. These include approval of packages and other activities identified in the regulations, but exclude inspection functions, which are undertaken by the CA. Transport Package Approvals and some other permissions are therefore performed by the ONR for all modes of transport throughout the UK. Further information is available in Section L.1 – Legislative and Regulatory System.

E.30. To support coordination between these regulatory bodies, a transport coordination group has been established. The group meets quarterly to discuss areas of mutual interest.

Enforcement on compliance with the licence and applicable regulations (Articles 19.2(iv) and (v))

E.31. In relation to spent fuel or radioactive waste management, all related activities must be carried out in compliance with the requirements of any nuclear site licence and/or environmental permits in place, and all relevant statutory provisions, which provide for nuclear and radiological safety and environmental protection (as described under Article 21). ONR enforce compliance with the licence conditions and the environment agencies enforce compliance with environmental permits and authorisations.

E.32. The purpose of enforcement is to:

- Ensure that operators take action to deal immediately with serious risks;
- Promote, achieve and sustain compliance with the law;
- Ensure that operators who breach regulatory requirements, and directors or managers who fail in their responsibilities, are held to account, potentially through prosecution.

E.33. ONR and the environment agencies are empowered to appoint inspectors in writing through issuing them with a warrant which confers legal powers on them to enforce compliance with relevant legal provisions. ONR inspectors are appointed under HSWA and the Energy Act 2013

(TEA13). Similarly, the environment agencies appoint inspectors under the Environment Act 1995 to enforce compliance with environmental permits and authorisations.

E.34. The approach taken by the regulatory bodies to ensuring compliance is broadly similar. In particular, each regulatory body carries out inspections of facilities to gather evidence and determine if they are being operated in compliance with relevant requirements. Inspectors have legal powers to conduct inspections. They also have a range of powers related to securing evidence during a formal investigation that could result in prosecution in a court of law.

E.35. Where non-compliances are identified, there is a graduated and proportionate range of enforcement action that can be taken depending of the seriousness of the shortfall. This begins with verbal advice through to prosecution in a court of law. Figure 35 below illustrates some of the powers available to the regulators. It excludes the primary powers that ONR may use under the site licence conditions.

E.36. All enforcement by regulators should be in line with the Regulators' Code [56] and regulatory principles required under the Legislative and Regulatory Reform Act 2006 [64]. In short, this requires regulators to be consistent and transparent in their expectations and proportionate in how they regulate and enforce compliance.

E.37. Where shortfalls are relatively minor with no significant consequence for safety, inspectors may address these through providing verbal advice or warning letters highlighting the shortfall and an expectation that they will be addressed by the operator.

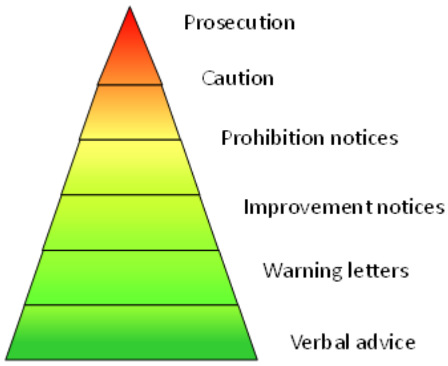


Figure 69: Enforcement powers available to inspectors from ONR and the environment agencies

E.38. Where there is a more serious non-compliance with legal requirements, an inspector can issue an Improvement Notice (IN), which indicates what improvements need to be made and on what the timescale. If there is a risk of serious personal injury or imminent risk of pollution, an inspector can issue a Prohibition Notice (PN). This stops the un-safe activity immediately, or as soon as can be done safely. INs and PNs can be appealed by the operator, in which case they are heard by an employment tribunal. Breach of notices and licence conditions can also lead to prosecution.

E.39. Prosecution in the law courts is reserved for serious breaches of the law. ONR and EA can initiate legal proceedings in England, and NRW and NIEA can initiate legal proceedings in Wales and Northern Ireland, respectively. In Scotland, ONR and SEPA must make a recommendation to the Procurator Fiscal Service. The decision to prosecute must consider the tests set down in the Code for Crown Prosecutors [65], which are that there should be sufficient evidence to provide a realistic prospect of conviction, and that prosecution would be in the public interest.

Responsibilities of Bodies Involved in Spent Fuel and Radioactive Waste Management (Article 19.2(vi))

E.40. There are a number of regulatory and non-regulatory bodies involved in the different steps of spent fuel and radioactive waste management. These bodies have well defined roles and responsibilities. These are summarised below under Article 20, with more detail provided in Section L.1 – Legislative and Regulatory System.

E.41. The responsibility for the safe management of spent fuel and radioactive waste lies exclusively with the holder of the nuclear site licence or environmental permit or authorisation. This includes operators who manage radioactive waste on nuclear and non-nuclear sites and radioactive waste disposal facilities. The regulatory bodies, ONR and the environment agencies (EA, SEPA, NRW, NIEA), are responsible for confirming that the operators are meeting their legal obligations.

E.42. The policies relating to spent fuel and radioactive waste management, including in relation to geological disposal and decommissioning of nuclear facilities, are established by the UK government and devolved administrations. These are implemented through strategies developed by government (such as in relation to management of LLW) or the NDA. Developments in policy, strategy and legislation are informed by stakeholder engagement and independent advice from expert bodies, such as the Radioactive Substances Policy Group (RSPG), the Nuclear Decommissioning Strategy and Policy Group (NDSPG), Committee on Radioactive Waste Management (CoRWM) and Committee on Medical Aspects of Radiation in the Environment (CoMARE).

E.43. The NDA owns and is responsible for the decommissioning and clean-up of 17 publicly owned civil legacy nuclear sites across the UK, ensuring that all radioactive and non-radioactive waste products are managed safely. The NDA sets the strategy for achieving this mission across its civil nuclear estate. The site operators (separate legal entities called Site Licence Companies) have responsibility for carrying out the decommissioning work in line with the NDA’s strategy and in compliance with legal requirements. The NDA also gives effect to government policies by implementing policy on the decommissioning of nuclear facilities and their sites and long-term management of LLW and radioactive waste in England and Wales, ensuring that waste is managed safely and optimally across the civil nuclear estate. The NDA is also responsible for scrutinising the decommissioning plans of EDF(NG), who own the operating fleet of AGR nuclear power stations.

E.44. The NDA manages the production of the UK UKRWI on behalf of government. This inventory provides the best available information on all categories of radioactive wastes and materials in the UK and is used by a range of stakeholders to inform waste management strategies and plans, and assist the UK in meeting international reporting obligations (discussed in Section D - Inventories and Lists).

E.45. The Ministry of Defence (MoD) also owns and manages significant quantities of radioactive waste and spent fuel. Although these are not included within the scope of this report it is worth noting that the MoD and the NDA meet routinely to discuss matters of mutual interest in managing these materials.

Consideration of whether to regulate radioactive materials as radioactive waste (Article 19.3)

E.46. The UK adopts a position in line with the definition of radioactive waste in the JC, i.e. "radioactive waste means radioactive material in gaseous, liquid or solid form for which no further use is foreseen by the Contracting Party or by a natural or legal person whose decision is accepted by the Contracting Party, and which is controlled as radioactive waste by a regulatory body under the legislative and regulatory framework of the Contracting Party”.

E.47. It is recognised that some nuclear materials that are not currently considered to be waste, could be considered to be classified as waste in the future, for example as a consequence of changed government policy on the management of plutonium and spent fuel that will not be reprocessed. The government, NDA and regulators encourage operators to consider this in their forward planning to ensure that these materials continued to be managed safely through to their eventual disposal.

Regulatory Body (Article 20)

Article 20:

1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 19, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.
2. Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate steps to ensure the effective independence of the regulatory functions from other functions where organizations are involved in both spent fuel or radioactive waste management and in their regulation.

E.48. There are several regulatory bodies that collectively implement the legislative and regulatory framework pertaining to the safe management of spent fuel and radioactive waste (Figure 33 and **Error! Reference source not found.** above). Each of these bodies is independent, with responsibilities and authority established in law, and is accountable to government. These bodies are summarised below and described in detail in Section L - Annexes.

- ONR is responsible for safety on nuclear sites in the UK, including the safe management of spent fuel and radioactive waste. SEPA also has responsibilities relating to radioactive waste management on nuclear sites in Scotland;
- EA, SEPA, NRW, NIEA are responsible for public and environmental protection in England, Scotland, Wales and Northern Ireland, respectively, including the safe management of radioactive waste disposal.

Section F - Other General Safety Provisions

Responsibility of the Licence Holder (Article 21)

F.1. The general safety provisions are substantively the same as presented in the sixth and earlier UK NRs. Therefore, to improve the focus of this section, it now provides only a high level overview of the general safety provisions, sufficient to demonstrate how the UK complies with Articles 21-26 of the JC, and consigns the presentation of the detailed information to Section L - Annexes.

Article 21:

1. Each Contracting Party shall ensure that prime responsibility for the safety of spent fuel or radioactive waste management rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility;
2. If there is no such licence holder or other responsible party, the responsibility rests with the Contracting Party which has jurisdiction over the spent fuel or over the radioactive waste.

Prime Responsibility for Safety (Article 21.1)

F.2. A fundamental principle of the UK legal system is that responsibility for health and safety and environmental protection clearly rests with those who own, manage, and control the work in industrial and commercial undertakings. The applicable laws explicitly place this responsibility for safety on persons carrying out such activities. A fuller explanation of the legal framework is provided in Section E – Legislative and Regulatory System.

F.3. For nuclear sites and facilities, the ultimate responsibility for safety lies with the holder of the nuclear site licence. Only a corporate body, such as a registered company or a public body can hold a licence and the licence is not transferable. As described in Section E – Legislative and Regulatory System, ONR administers the licensing process through which it grants a licence to a corporate body, to use a defined site for specified (prescribed) activities. Through its core regulatory functions ONR confirms that nuclear site operators are meeting their legal obligations to protect their workforce and the public from risk so far as is reasonably practicable. The licence remains in place for the whole lifecycle of the site, until the site is delicensed, usually when ONR judges that there ceases to be any danger from ionising radiation from anything on the site.

F.4. Similarly, the person authorised to operate a regulated facility or carry out regulated activities must do so in compliance with any environmental permits received from the environment agencies (EA, SEPA, NRW or NIEA). The environment agencies ensure compliance with the permits and authorisations through their regulatory functions.

Contracting Party Responsibility if there is no Licence Holder or Other Responsible Party (Article 21.2)

F.5. The UK government takes the steps necessary to ensure that spent fuel and radioactive waste are managed in a safe manner. There should always be a responsible party for managing spent fuel and radioactive waste safely, either a holder of a nuclear site licence, or of an environmental permit or authorisation. Every employer who manages such materials has responsibility for ensuring the safety of their undertakings under HSWA74. Therefore, the UK has a very high degree of confidence that there are no cases where spent fuel or radioactive waste is being managed outside the legal framework and is not under close regulatory scrutiny.

F.6. Any radioactive waste managed on a site without a nuclear site licence is subject to the full requirements of the environmental permitting legislation. The environment agencies have the powers under EPR16 (England and Wales), EASR18 (Scotland) and RSA93 (Northern Ireland), to arrange disposal of radioactive waste if they judge this appropriate and to recover the costs of doing so.

Human and Financial Resources (Article 22)

Article 22: Each Contracting Party shall take the appropriate steps to ensure that:

1. qualified staff are available as needed for safety-related activities during the operating lifetime of a spent fuel and a radioactive waste management facility;
2. adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning;
3. financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility.

F.7. The means to comply with this Article have not changed substantively since the sixth UK NR. The significant progress in addressing the challenge of maintaining and enhancing the nuclear skills base to support on-going operations, decommissioning and future new build of nuclear power stations is presented below.

Availability of Qualified Staff (Article 22.1)

F.8. In general, all employers are required to ensure the competence and training of staff with safety-related roles under HSWA74 and the MHSWR99.

F.9. This is complemented by the requirements of nuclear site licences and environmental permits. The requirements of a number of licence conditions and other legal instruments place responsibility on the operator to ensure that its personnel are competent and have adequate training and that there are sufficient numbers, to enable them to perform any roles that may affect safety.

F.10. Only suitably qualified and experienced persons (SQEPs) can perform any duties which may affect the safety of operations on the site or any other duties under the site licence. The operator is also required to maintain an adequate ‘nuclear baseline’, the means by which it demonstrates that its organisational structure, staffing levels and competencies are, and remain, suitable and sufficient to manage safety.

F.11. Similarly, environmental permits and authorisations issued under EPR16, EASR18 and RSA93 also require the site operator to use sufficient competent persons and resources when operating and managing the permitted activity. ONR, EA and NRW have the power to prevent a person carrying out a particular role if they deem them unfit to act in that capacity.

F.12. Where external contractors are used, the operator must be in control of activities on the site and maintain responsibility for the safety of any activities carried out by the contractor. ONR and the environment agencies expect the operator to take the ‘intelligent customer’ role, with sufficient competence in the operator’s organisation to specify, oversee and accept nuclear safety-related work undertaken on its behalf by the contractors [66]. Contractors also have legal duties to undertake their activities safely when working on nuclear sites under general health and safety legislation.

National initiatives to maintaining and enhancing the National Nuclear Skill Base

F.13. The UK nuclear workforce (including supply chain) has been estimated by industry to be around 89,000 FTE in 2018, across civil and defence. The overall forecast demand outlined in the Nuclear Workforce Assessment (NWA) [67] is based on 2 scenarios, a 9 GWe model (Scenario 1) and an 18 GWe model (Scenario 2). To meet both replacement demand and expansion from new projects, an inflow of new workers is required of approximately: 3200 a year for Scenario 1 and 4800 a year for Scenario 2 in the period to 2025. By 2030 around 40,000 full time posts will need to be filled for Scenario 1, and 60,000 for a potential Scenario 2. With on-going operations, decommissioning and site clean-up, together with a new nuclear power station currently under construction at Hinkley Point C (and potentially additional ones to follow), this is expected to increase significantly. Findings from the Nuclear Workforce Assessment (NWA) [67] estimate a peak workforce demand of around 100,600 full time equivalents personnel in 2021. This will require an inflow of around 7000 new full time equivalents personnel per year.

F.14. Key challenges to maintaining an adequate and sustained skills capability to support the nuclear sector and its future ambitions include demographics within the industry, with an ageing workforce containing a high proportion nearing retirement, availability of subject matter expertise in specialist areas, and the need to support jobs in the often remote locations of nuclear facilities.

F.15. The NSD [42], part of UK-wide industrial strategy, sets out a series of initiatives and commitments to support the development and growth of the nuclear sector in the UK in the next decade. The NSD proposes action, with strong collaborative working, including partnerships between government, Site Licence Companies (SLCs), supply chain and training bodies, to secure an adequate and sustained supply of suitably qualified and competent personnel for the UK nuclear sector.

F.16. The Nuclear Skills Strategy Group (NSSG) was established by employers to work with public bodies to address the strategic skills needs of the nuclear sector in the UK. It has taken responsibility to deliver the “People” section of the NSD. It published its updated Nuclear Skills Strategic Plan [68] in December 2018, a key milestone set out in the NSD. The plan is aimed at developing sustainable skills infrastructure, processes and training provisions needed to secure the required supply of suitably qualified and competent personnel for the UK nuclear sector. This is creating a skills base to meet the sector’s skills requirements, principally by increasing the supply of suitably qualified and experienced apprenticeships, graduates and supporting transition of experienced people with transferable skills from other industries. It is recognised that the skills required for nuclear work are diverse, including subject matter experts (a relatively small number of experts with specialist skills which take a long time to acquire), nuclear skills (specialist skills only required in the nuclear industry) and generic skills (those skills that are most transferable across sectors).

F.17. The Strategic plan is aligned around the five key delivery themes in the NSD relating to people:

- Enhanced skills leadership. Committing the industry to meet its skills requirements by drawing from a more diverse talent pool, including significantly increasing female representation to 40% by 2030 (from the current ~20%). And to provide effective processes to transition experienced people from other industries into nuclear;
- Local apprenticeships. Improving investment in training of apprenticeships and enabling the supply chain to increase the number of apprenticeships at the local level and ahead of demand;
- Staying at the cutting edge. Ensuring that the UK has sufficient R&D capability and subject matter expertise in specialist areas, through partnerships with universities and through provision of advanced and post-graduate training;
- Sector transferability. Facilitating the transition of experienced personnel with transferable skills from other industrial sectors, such as oil and gas and manufacturing, into the nuclear sector; and
- Exciting the next generation about nuclear. Maximising the visibility of the nuclear sector to young people to promote careers in nuclear.

F.18. The NSSG has published an Equality, Diversity and Inclusion (ED&I) Strategy [69] with the aim to tap into the pools of talent across UK society which are currently underrepresented. This will support skills issues by improving diversity of thought and attracting and retaining skilled people to the sector. Its five strategic aims are:

- To support the nuclear industry to foster a more Inclusive Culture;
- To support social inclusion and mobility through improved Local Apprenticeships;
- Provide guidance for the sector to stay at the cutting edge in nuclear skills and expertise through continued innovation and growth;
- Provide the information, tools and share best practice for more agile and flexible ways of working; and
- Support the industry in exciting and attracting the next generation of skilled personnel into the nuclear industry through improved attraction and branding strategies.

F.19. The NDA has a strategic role to deliver nuclear decommissioning and clean-up across its civil nuclear sites and a statutory duty under the Energy Act 2004 [70] to ensure adequate skills are available to deliver this mission. The NDA People Strategy [71] has objectives to ensure that the nuclear industry has the capability, resources and supporting infrastructure to carry out this mission efficiently and effectively. The strategy emphasises the importance of collaboration between the NDA and SLCs and other stakeholders to provide a competent and skilled workforce, with transferable and mobile skills and capability, across the NDA estate and to increase supply chain capability. To fulfil its responsibilities under the NSD and Energy Act, the NDA is taking a lead role in the NSSG and has aligned its people strategy to reflect its national targets and aspirations.

F.20. The NSSG has active programmes, delivered in partnership with industrial and academic partners, to drive progress and oversee the delivery of skills programmes, activities and initiatives for the UK nuclear industry, to address the key risks set out in the nuclear skills strategy. This includes coordinating the skills-related activity of skills bodies and associations in the skills system, overseeing provision of skills products and services to the nuclear industry.

F.21. There are a diverse range of training bodies and skills programmes available. Particularly notable ones are:

- National Skills Academy Nuclear (NSAN) [72]: Provides skills training, guidance and innovative skills solutions to the nuclear industry. This includes providing numerous training and qualifications through its provider members via their eLearning platform. Over the last three years, over 12,000 NSAN programmes have been delivered in a broad range of areas (including radioactive waste management, nuclear codes and standards, leadership).

  NSAN also offers financial support through a bursary, to support training and further development of people entering or working within the nuclear sector;

- Apprenticeships: Overseen by the Nuclear Standards Advisory Group, the sector has developed five nuclear-specific Apprenticeship Standards for England. These range from entry technician level to degree apprenticeship level, with standards for Bachelor's, Master's and Doctoral level degree apprenticeships under development. The nuclear sector currently has approximately 2,000 apprentices in the workforce.

  The Nuclear Gateway online placement service [73], connects employers with interested candidates looking for apprenticeship or graduate opportunities. Candidates are invited to enrol onto the Nuclear Gateway from nuclear companies that have successfully completed an apprentice or graduate recruitment campaign which has resulted in a surplus of high quality candidates beyond their own requirements;

- National Nuclear Laboratory [74]: Has a specific remit from government to maintain and develop key skills and capabilities in the nuclear R&D sector and operates a subject matter expert development model, in collaboration with NSAN;

- National College for Nuclear [75]: A national college working in partnership with major employers in the nuclear industry, delivering high-level technical skills training, qualifications and hands-on vocational experience, as part of the government's integrated education plan to deliver a skilled UK workforce. The college delivers a wide range of training, including post-16 access courses, apprenticeships and degree level qualifications;
- Women in Nuclear (WiN) [76]: To address the nuclear industry's gender imbalance, and achieve a step-change in the representation of women in leadership and to engage with the public on nuclear issues. WiN is influencing within the industry to significantly increase the representation of women entering into training and all roles within the industry.

  WiN has published the Nuclear Sector Gender Roadmap [77], setting out the specific measures being taken over the next ten years to achieve these objectives;
- Advanced and post-graduate training provided in partnership by universities. Examples include:
  - Nuclear Technology Education Consortium (NTEC) [78]: A consortium of UK universities and institutions providing post-graduate education in nuclear science and technology;
  - Doctoral (PhD) level programmes that target key challenges faced by the nuclear sector, ensuring appropriate R&D in key areas (including decommissioning and spent fuel/radioactive waste management) and to help maintain an advanced academic nuclear skills base and a pipeline of highly qualified potential industry and supply chain recruits with a strong nuclear background.

    Several university-based Centres for Doctoral Training (CDTs) have been established, including Next Generation Nuclear and GREEN, and DISTINCTIVE [79], to help maintain an advanced academic nuclear skills base and a pipeline of highly qualified potential industry and supply chain recruits with a strong nuclear background. These are funded by a combination of industry, research council and university monies, with significant industry input throughout to ensure that the research stays relevant to the industry needs.
  - NDA, Sellafield and RWM each fund PhD level research to support their operations and future requirements, in total supporting over 150 PhD students.

F.22. NSSG monitors the current and future capability required in the higher level skills category. It has utilised data from NWA and research exercises to understand the areas of capability currently experiencing shortages, whilst at the same time encouraging organisations to consider what areas of research capability will be required in the future.

F.23. Across all work-streams, the NSSG is targeting a more diverse workforce, recognising the innovation that people from different backgrounds can bring to the nuclear sector. As part of the work with the NSD, the NSSG is exploring ways of developing this more diverse and inclusive sector. Working with other NSD subgroups, the work that the NSSG is undertaking will contribute to greater innovation, which in turn can potentially lead to increased productivity, making the UK more competitive in the international market.

Enhancing the nuclear skills base

F.24. The NSSG strategic skills plan, delivery plan and associated training infrastructure has successfully delivered a broad range of skills development and training. This is delivering against challenging targets to provide the required supply of skills to the sector.

F.25. Some areas of notable successes from across the training landscape are:

- Nucleargraduates [80]: A graduate training scheme, through which recruits undertake at least three placements with different organisations across the nuclear industry in order to build their skills and gain a wide variety of experience before starting work with a sponsor employer. Over 400 graduates have now been through the scheme since it was established by the NDA in 2008. ONR has sponsored 37 graduates through the scheme and others have been sponsored by the EA who have also hosted numerous placements by graduates wishing to gain a better understanding of the role of the regulator;

- Nuclear Career Pathways [81]: An interactive platform, providing information on a range of roles available in the nuclear sector, aimed at entrants, transferees from other sectors, and employees planning their career paths. Over 1200 unique users have accessed information about careers in the sector since its launch in March 2020;
- There has been a substantial expansion and take up of apprenticeships and graduate training and employment opportunities;

  In support of specific areas of work, the construction project for Hinkley Point C has created 529 apprenticeships and aims to create another 1000 over the course of the construction phase [82];

  Sellafield continues to invest heavily in training new staff, around 160 apprentices and around 60 graduates recruited each year, together with around 35-40 student industrial placements. Additionally, as part of its commitment to continuous professional development, around 350 Sellafield staff were enrolled on higher education training courses in 2019/20;

  The target to increase female representation to 40% is firmly and explicitly embedded throughout the industry. The entry of females into apprenticeships and early career training is high, with a target for 50% representation in new apprenticeships by 2021;
- Over the last 3 years, the National College for Nuclear has successfully developed some 2000 students, with 30% female representation;
- NDA continues to increase the numbers of apprenticeships and graduates recruited, with over 750 apprentices and 200 graduates now on the development programmes. Similarly, ONR has continued to expand its recruitment of apprentices for administrative and specialist roles, including nuclear engineering;
- The partnerships with academia continue to produce nuclear specialists. Around 72 nuclear-related PhDs have commenced annually, delivering essential high level skills and nuclear subject-matter experts to protect fragile skill areas. As of this year, over 200 researchers have graduated through the CDTs, the majority of them entering work in the nuclear sector.
- Apprenticeship standards for first degree-, master's degree and PhD levels are being developed. All these standards will use the apprenticeship model to develop a pipeline of highly skilled people with the knowledge, skills and behaviours acquired on the job, in areas where there are identified skills shortages.

  RWM established the Research Support Office for GDF, a partnership with UK universities to facilitate co-ordinated collaboration on academic research relevant to geological disposal;
- NSSG support the Alpha Resilience and Capability (ARC) programme. This has established a working group to maintain adequate expertise in plutonium management and developing a new accredited training centre to meet increasing demand for skills;
- The Sellafield Project Academy is a centre of excellence for the development of project delivery skills. It provides some 45 courses, including those leading to professional or degree level qualifications, ensuring that the organisation has staff with the skills and knowledge required to deliver SL's unique and complex projects. The Academy has delivered a large amount of training over the last few years, with 4000 staff taking

courses (and over 3000 signed onto future courses), and a total of around 70,000 hours of training provided overall;

- There has been considerable success in attracting talent from other sectors and facilitating transition to the nuclear sector [83]. Currently, around 60% of new recruits are from outside the nuclear sector. The recruitment and appointment of the new Magnox Ltd senior leadership team included a number of such recruits. Around twenty operational staff from the Cottam coal-powered station transferred to work with EDF(NG)'s nuclear fleet retaining key skills.

Financial Resources (Article 22.2 and 22.3)

F.26. There is an absolute legal duty that licensees will have sufficient funding to operate their sites safely, including the management of radioactive wastes and, where relevant, spent fuel. This requirement (LC36) endures through the complete lifecycle of the facility. Where a licensee is part of a group of companies with a parent company or organisation, such as the NDA, it is expected that the parent will provide sufficient funds for the licensee to carry out its activities and to ensure that nuclear safety is not compromised.

F.27. Financial arrangements for the disposal of high-activity sealed sources are detailed in Section J – Disused Sealed Sources.

Financing Current Decommissioning Programmes and Radioactive Waste Management

F.28. The audited accounts of the UK's operators of spent fuel, reprocessing and radioactive waste management facilities include details of waste management costs and the provisions made to meet them. There is currently no available disposal route for HAW in the UK, so such wastes at present have to be kept in safe and secure interim storage awaiting development of the planned GDF.

F.29. The cost of managing radioactive waste during the operational phase of a facility is typically spread across materials, services and staff costs in the reported accounts. Materials and services costs in accounts tend to include the costs associated with disposals of LLW, with an estimated price that reflects both the short-term operational cost and onwards disposal costs.

F.30. The role of the NDA as the organisation which is charged with the mission to decommission and clean up the UK's earliest nuclear sites safely, securely and cost-effectively is explained in Sections E and L. The NDA requires its site operators to prepare detailed plans for their sites to a prescribed format, known as Lifetime Plans (LTPs). LTPs cover commercial activities as well as decommissioning and clean-up costs.

F.31. Although the plans are detailed, there is significant inherent uncertainty in the future cost estimates that underpin the provisions for management of spent fuel and radioactive wastes on the NDA sites. Some specific uncertainties that the NDA and its SLCs are working to address include:

- site end-states;
- inventory of material to be retrieved from legacy facilities;
- performance of aged infrastructure that is reaching the end of its operational life;
- contaminated land quantities and treatments required;
- programming of work and risks arising from programme inter-dependencies; and
- disposition plans for wastes – HLW, ILW, and LLW – and spent fuels

F.32. The NDA business plan for 2020/21 indicated the NDA's total planned expenditure for year to be is £3.391 billion, of which £2.785 billion will be funded by UK government and £0.606 billion by income from commercial operations. Planned expenditure on site programmes will be £3.140 billion, while non-site expenditure is expected to be £0.251 billion. Further information on NDA funding and budget is provided in Section L - Annexes.

Funding for Future Decommissioning and Spent Fuel (AGRs and PWRs)

F.33. The UK government expects all nuclear operators to take the steps necessary to ensure that they have sufficient financial provision to fund the decommissioning work required on the sites they are responsible for.

F.34. In 2005 the UK government created a new independent funding mechanism, the Nuclear Liabilities Fund (NLF). The NLF was set up to fund decommissioning of the PWR at Sizewell B (SWB) and the fleet of AGR stations, and also to fund specified liabilities associated with SWB and AGR spent fuel management. EDF(NG) prepares and submits a decommissioning strategy and plan every five (or three years prior to the station closure), which is subject to review and approval by the NDA. In addition, EDF(NG) can also apply for funding from the NLF for work carried out within the agreed scope of the NLF, subject to review and approval by the NDA. The UK government guarantees the NLF and retains the ability to compete all or part of the decommissioning scope to achieve improved value for money.

Funding for Waste Management and Decommissioning of Proposed New Nuclear Power Stations

F.35. Under the Energy Act 2008 [84] all new nuclear power stations must have a government approved Funded Decommissioning Programme (FDP) before operations begin. The programmes ensure that new nuclear power station operators have secure financing arrangements in place to meet the full costs of decommissioning, waste management and the disposal of spent fuel. The FDP is also used to satisfy licensing regime requirements regarding decommissioning liability.

F.36. The FDP has a strong governance framework that helps to further ensure a prudent approach to decommissioning. This includes working with technical decommissioning experts, such as the NDA, and consulting relevant regulators, such as the ONR and the EA. Furthermore, before the Hinkley Point C FDP was accepted by the Secretary of State, it was reviewed by the independent Nuclear Liabilities and Financing Assurance Board (NLFAB) to ensure it met the criteria of prudence. Given that the FDP is agreed at the early stages of constructing a nuclear power plant, governance measures have been put in place to ensure that the estimated liabilities remain as accurate as possible well into the future. These measures include receiving cost and financing verification reports from independent third-party experts; annual reports to ensure that the fund is on-track and a wider ranging review of the FDP costs every five years.

F.37. A summary of the roles and responsibilities related to financial provisions for decommissioning and waste management is provided in Figure 36.

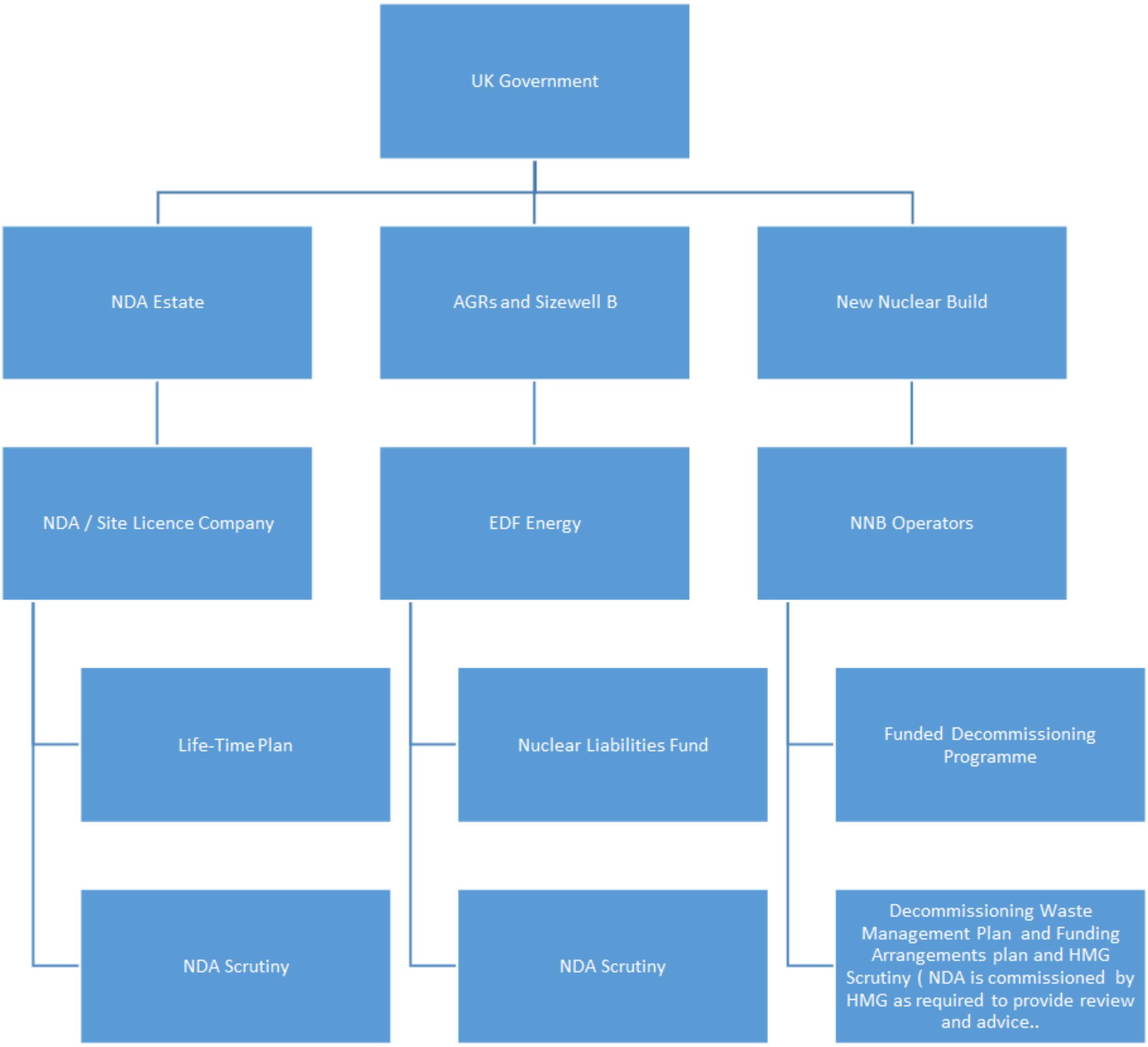


Figure 71: Roles and Responsibilities related to Decommissioning and Waste Management Funding

Quality Assurance (Article 23)

Article 23: Each Contracting Party shall take the necessary steps to ensure that appropriate quality assurance programmes concerning the safety of spent fuel and radioactive waste management are established and implemented.

F.38. Compliance with Article 23 is demonstrated in a way that has not changed substantially since the sixth UK NR.

F.39. The use of the term Quality Assurance (QA) is becoming outmoded and is now generally considered to be part of what international standards, such as the IAEA Safety Standards, call the Management System (MS). All of the elements of effective QA are included in the MS of the UK organisations responsible for aspects of the safe management of radioactive waste and spent fuel as well as the MS of the regulatory bodies, and the organisations that transport radioactive material between the sites.

Requirements for Management Systems

F.40. On the licensed nuclear sites LC17 (Management Systems) requires the operators to make and implement adequate quality MS arrangements in respect of all matters which may affect safety, this includes ensuring their management systems are effective in managing radioactive waste, including its minimisation and accumulation on-site. Similar requirements are also a feature of the discharge permits and authorisations issued by the UK environment agencies.

F.41. In practice the operators base their quality MS on recognised national or international quality management standards. ONR expects licensees to establish and maintain integrated management systems, as set out in IAEA GSR Part 2 and its supporting safety guides, to ensure safety and environmental management is a strong consideration for management of the operators' activities and processes. Operators who use the supply chain to provide goods and services which may affect safety or environmental protection usually specify requirements for suppliers to adopt management systems (based mainly on relevant standards such as ISO 9001).

F.42. Radioactive waste may be managed by a series of organisations or be contracted-out to bodies that may carry out one or more parts of the overall waste management process. In such circumstances, the ONR and the environment agencies place particular emphasis on the importance of licensees maintaining effective oversight of the entire waste management system and integrating the individual steps.

Management Systems' Implementation

F.43. Licensees' MS provide the principal means by which they demonstrate compliance with the licence and permit/authorisation conditions. The arrangements are subject to periodic management review to ensure that they remain valid and identify any opportunities for improvement that can be made. In addition, they are also subject to internal audit.

F.44. Licensees deploy integrated MS. This promotes a consistent approach to the wider aspects of their activities, e.g.: quality/safety, environment, security, transport, safeguards, and other business activities. This simplifies the management system and reduces the likelihood of incompatible arrangements. However, due priority is still given to safety.

F.45. Most of the operators' MS are certified to ISO 9001 / ISO 14001 by independently accredited third parties. These standards require periodic audits and surveillance of their management systems to retain certification.

Graded Application of Management System Requirements

F.46. The extent of MS controls applied to activities by the operator is graded to provide a hierarchy of controls proportionate to the safety significance and the related risk associated with the activity being carried out. This approach ensures that appropriate and proportionate levels of controls are in place (e.g. scrutiny, supervision, inspection, monitoring, documentation, training, audit and surveillance) with respect to the safety significance of the activities undertaken or the items or services being procured.

Performance monitoring and improvement

F.47. To assess conformance to, and the effectiveness of, their MS operators and suppliers carry out, or are subject to, a range of monitoring and measuring activities. This includes: quality control inspections, process monitoring, self-assessment, multi-layered oversight, independent internal and external audit and review, benchmarking, national and international peer review missions.

F.48. The ONR and the environment agencies carry out inspections of the licensees' quality management arrangements as part of their regulatory activities.

F.49. Licensees have arrangements for reporting, assessing and learning from experience, such as non-conformances and incidents. They also have access and use feedback from national and international sources e.g. IAEA and NEA databases.

Management of Records

F.50. UK experience has shown that information or 'knowledge management' is an important matter, and if over-looked can result in significant difficulties in subsequent years. Therefore, a particularly important aspect of the MS related to radioactive waste and spent fuel management, and for decommissioning, is that of record or information management. The timescales over which radioactive waste / spent fuel can accumulate is often prolonged. In addition where decisions are made to defer decommissioning of nuclear facilities for long periods, then it is important that the information necessary for safe final dismantling, including the management of any radioactive waste generated, is available to those who will be doing the work in the future. Thus, it is key that accurate records are retained that can be accessed for many years, or decades into the future.

F.51. UK licensees continue to package radioactive waste now for future geological disposal. RWM through its role as the GDF developer specifies the arrangements for producing and maintaining records to provide confidence that waste packages will be compatible with the requirements for geological disposal without the need for future rework or repacking. Waste package records will ultimately be required to demonstrate that packages meet the acceptance criteria for a GDF, as well as fulfilling other requirements for transport and interim storage.

F.52. There is already a wide range of data and records and other information associated with waste packages. These are held in differing formats, in diverse locations. Over time workforce changes also present a risk to the long-term retention of critical knowledge. Recognising these challenges RWM is developing a waste package assurance programme that will manage the potential loss of information needed to demonstrate packages can be safely transported and accepted for geological disposal.

F.53. Some UK developments in this area are outlined in Section B - Policies and Practices under the sub-section entitled Knowledge / information management.

Operational Radiation Protection (Article 24)

Article 24:

1. Each Contracting Party shall take the appropriate steps to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility:
   - i) the radiation exposure of the workers and the public caused by the facility shall be kept as low as reasonably achievable, economic and social factors being taken into account;
   - ii) no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection; and
   - iii) measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.
2. Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:
   - i) to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account; and
   - ii) so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection.
3. Each Contracting Party shall take appropriate steps to ensure that during the operating lifetime of a regulated nuclear facility, in the event that an unplanned or uncontrolled release of radioactive materials into the environment occurs, appropriate corrective measures are implemented to control the release and mitigate its effects.

F.54. Compliance with Article 24 is demonstrated in a way that has not changed substantially since the sixth UK NR. The successful reduction in radioactive discharges to sea, contributing to meeting the objectives of the OSPAR radioactive substances strategy, is presented as an example of demonstrable success.

Optimisation of Exposure to Levels As Low As Reasonably Achievable (ALARA) / As Low As Reasonably Practicable (ALARP) (Article 24.1(i))

F.55. The Ionising Radiations Regulations 2017 [85] and Ionising Radiations Regulations (Northern Ireland) 2017 [86] set out the main legal requirements for controlling and minimising the exposure of workers and the public to ionising radiation. These regulations are supported by an ACoP [87] which gives practical guidance on the most appropriate methods of complying with the legal requirements.

F.56. The overarching requirement of IRR17 Regulation 9(1) is that the employer must restrict SFAIRP exposure of employees and the public to ionising radiations. This principle is equivalent to reducing the risk from radiation exposure to levels that are ALARP, which in turn is equivalent to ALARA; economic and social factors being taken into account.

F.57. For environmental protection, employers demonstrate that exposures are optimised through the use of BPM and BPEO in Scotland and Northern Ireland; and in England and Wales, use of BAT, which is broadly equivalent to a combination of BPM and BPEO.

F.58. In support of the regulatory requirements for a nuclear site, ONR has included in its SAPs some lower dose targets called Basic Safety Objectives (BSOs) of 1 mSv/year for employees working with ionising radiation, 0.1 mSv/year for other employees, and 0.02 mSv/year for any person off the site, which are particularly applicable to new facilities. The BSO represents a dose value below which the regulator will not normally use its resources to seek further improvements, provided it is satisfied with the validity of the licensee’s arguments. It does not represent a notional value of optimisation and a radiation employer at a licensed nuclear site would still have to seek further dose reductions below the BSOs if these were reasonably practicable.

F.59. On nuclear sites, the IRR17 requirements are augmented by nuclear site licence conditions whereby licensees must optimise protection to provide the highest level of safety that is reasonably practicable. This optimisation would include, but not be limited to, the following criteria reflecting the fundamental principles of the SAPs:

- the safety of the public and workers from the effects of ionising radiation should be assessed during design, construction, commissioning, operation and decommissioning. Through this systematic process of safety assessment, the duty holder for a nuclear site or facility must demonstrate effective understanding of the hazards;
- measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm;
- all reasonably practicable steps must be taken to prevent and mitigate nuclear or radiation accidents; and
- arrangements must be made for emergency preparedness and response in the case of nuclear or radiation incidents or accidents.

F.60. Licensees are required under IRR17 to restrict exposure by means of engineering controls, such as shielding, physical separation, containment, ventilation and warning devices, where these are reasonably practicable, rather than relying on systems of work or personal protective equipment. At nuclear installations, whether or not licensees' employees undertake the work, the licensees are ultimately responsible for controlling work and ensuring doses to individuals are ALARP.

F.61. A dose constraint is a prospective restriction on the individual dose caused by a source of ionising radiation, which serves as an upper bound on the dose to optimise the protection and safety of persons who may be affected by the source. IRR17 Regulation 9 requires employers to use dose constraints, where appropriate, in the planning stage of radiation protection. This is achieved through good planning of work activities. In general, licensees have considerable experience in developing dose databases which provide accurate dose forecasts for planned tasks.

Regulatory Activities

F.62. The provisions of IRR17, for both workers and members of the public, at spent fuel, reprocessing and radioactive waste management facilities, are enforced by the ONR. ONR monitors compliance with these provisions by targeted inspections of arrangements on site. It should be noted that the Health and Safety Executive (HSE) is the enforcing authority for the IRR17 on non-nuclear sites.

Dose Limitation under National Prescriptions (Article 24.1(ii))

F.63. IRR17 sets annual dose limits for all persons exposed as the result of work with ionising radiation. The dose limits in IRR17 are directly related to internationally endorsed standards on radiation protection. For workers the annual dose limit is 20 mSv but IRR17 also allows for dose limitation for an individual worker in specified circumstances to be based on a dose of 100 mSv averaged over a period of five consecutive calendar years, with a maximum of 50 mSv in any one year. However, this flexibility is acceptable only if the licensee can demonstrate to HSE's or the ONR's satisfaction that an annual limit of 20 mSv is impracticable for that person.

F.64. The dose limit for other persons i.e. employees not working directly with radiation is set at 1 mSv per year.

F.65. Additionally, for workers not engaged directly in work with ionising radiations the ACoP that supports IRR17 considers that employers should apply dose controls to ensure that such individuals do not exceed 1 mSv per year, in essence they are treated as the public.

F.66. Notwithstanding dose limits, the employer responsible for the work must restrict exposure SFAIRP to both worker and public.

F.67. Table 4 below indicates that occupational exposure of classified[1] workers employed in relevant activities indicate that doses[2] to individuals are generally low and well controlled.

Table 4: Summary of UK workers' dose in reprocessing, radioactive waste treatment, and decommissioning

	Year[3]					
	2013	2014	2015	2016	2017	2018
Total Classified Workers[1,2]	6049	7544	6948	4251	3614	3388
Collective Dose (Man-mSv)	2950	3703	3989	2758	2286	1807
Mean dose (mSv)	0.5	0.5	0.6	0.6	0.6	0.5
6.1 to 10mSv	63	33	37	40	33	12
10.1 to 15 mSv	1	0	0	3	1	0
15.1 to 20 mSv	0	0	0	1	0	0
>20 mSv	0	0	0	0	1	0

() In the UK classified workers are those workers that are likely to receive a radiation dose greater than three-tenths of a relevant dose limit in a year (e.g. 6mSv in the case of whole-body exposure)

(2) All doses to classified persons are assessed by a dosimetry service approved by HSE for the measurement and assessment of doses for the relevant type of radiation.

(3) 2018 is the latest year that collated annual doses are available when drafting this report.

F.68. Since the sixth UK NR only one worker has exceeded the annual dose limit. This was as the result of a serious personal contamination incident resulting from a puncture wound to an individual performing tasks within a glove box. This incident was investigated as described below.

F.69. Whilst public doses are not directly measured the UK employers are required to estimate public doses arising from their activities to ensure compliance with the dose limits. Public doses from all pathways are independently assessed by the environmental and food standards' agencies and are reported annually in the Radioactivity in Food and the Environment (RIFE) reports [88], confirming that no member of the public has exceeded a dose limit.

Investigations

F.70. If an employee has a recorded whole-body dose greater than 15 mSv (or a lower level established by the employer) for the year, the employer must carry out an investigation (under IRR17 Regulation 9). The purpose of this investigation is to establish whether enough is being done to restrict exposure SFAIRP.

F.71. IRR17 Regulation 26 requires employers undertaking work with ionising radiation to inform the ONR if an exposure in excess of a dose limit occurs or is suspected, whether this arises from a single incident or through an accumulated dose. In such circumstances, the employer must complete an investigation. As a result of an incident (rated at INES Level 2) at Sellafield in 2017 a significant overexposure occurred and was investigated both by the employer, Sellafield Ltd, and ONR. As a result of ONR's investigation, Sellafield Ltd, was taken to court and prosecuted.

Sellafield pleaded guilty to the offences cited and in April 2019 received a substantial fine of £380,000.

Measures to Prevent and Mitigate Unplanned and Uncontrolled Releases of Radioactive Materials into the Environment (Articles 24.1(iii) and 24.3)

F.72. The UK nuclear licensing regime, as applied to spent fuel, reprocessing and radioactive waste management facilities, is designed to ensure that there is a very low probability of uncontrolled accidental releases of radioactivity into the environment. This is achieved by the requirement for licensees to demonstrate, through a safety case, that the design of any plant has taken into account the full range of reasonably foreseeable fault conditions. Accordingly, plant design should provide protection, so that if a fault condition occurs, safety systems act to ensure that any release of radioactivity is prevented or mitigated against to reduce risks so far as is reasonably practicable.

F.73. Should a fault occur, measures to bring back under control any unplanned releases or uncontrolled releases of radioactivity with the potential to travel outside the boundary of the licensed facility, and to mitigate their effect, are dealt with under Article 25 Emergency Preparedness.

F.74. IRR17 Regulation 31 requires employers using radiation that are not on nuclear licensed sites to notify HSE in the event of an uncontrolled leakage or escape of a radioactive substance that exceeds the values on quantity and concentration specified in IRR17 Schedule 7.

Radioactive Discharges (Article 24.2)

F.75. Domestic legislation places a duty on the environment agencies to exercise their relevant functions to ensure that radiation exposures to the public resulting from radioactive discharges and the disposal of radioactive waste are optimised and meet the national prescriptions listed below.

Permitting and Authorisation Regime for Discharges

F.76. Operators must obtain an environmental permit under EPR16 in England and Wales, or an authorisation under EASR18 in Scotland or under RSA93 in Northern Ireland, for discharge of radioactivity to the environment under normal operations, or disposal by means of burial, incineration or transfer of waste off the site. Environmental permits and authorisations may:

- specify the disposal routes to be used, and place limits and conditions on disposal. Limits and conditions can apply exclusively to an individual disposal route;
- place a requirement to use BAT under EPR16 (England and Wales) or BPM under EASR18 (Scotland) and RSA93 (Northern Ireland) to avoid or minimise waste arising, the radioactivity discharged to the environment, and to minimise the radiological effects on the environment and on members of the public;
- require sampling and analysis to determine compliance with permit or authorisation conditions, reporting of the quantities of radioactive waste disposed of and any instance of non-compliance with limits;
- specify improvements in waste management arrangements (including benchmarking against industry good practice); and
- set conditions, including those relating to management systems, record keeping and provision of information to the agencies.

F.77. When the waste has sufficiently low-levels of radioactivity, it may be out of scope of the regulations (excluded) or subject to conditional exemption from EPR16, EASR18 and RSA93 as appropriate. Exempted activities are typically not subject to the full requirements of the regulations, although may have some qualifying conditions attached (e.g. disposal of a limited volume, or alongside a specified volume of non-radioactive waste).

F.78. For environmental permits or authorisations, the ONR is consulted on the management/disposal of radioactive wastes from nuclear licensed sites and on the setting of limits and conditions.

F.79. The regulatory bodies carry out checks on the actual discharges made, in terms of activity and radionuclide composition, and have powers of enforcement including prosecution under EPR16, EASR18 or RSA93 if the terms of an environmental permit or authorisation are breached. The environment agencies also carry out their own independent monitoring of radioactivity in the environment.

F.80. The joint responsibility for regulating doses to the public requires close co-operation between the ONR and the environment agencies. Memoranda of Understanding are in place to ensure that regulatory activities are consistent, co-ordinated and comprehensive.

Optimisation of Exposure from Radioactive Waste Disposal to ALARA and Disposal Limits

F.81. Operators are not only required to comply with numerical limits on the levels of activity that may be discharged, but also to use BAT under EPR16 (England and Wales) or BPM under EASR18 in Scotland and RSA93 in Northern Ireland, to minimise the amount of waste generated and radioactivity discharged. Operators are required to use BAT or BPM to minimise the volume and activity of:

- radioactive waste produced, which will require ultimate disposal under the environmental permit or authorisation;
- radioactive waste disposed of to the environment; and
- radioactive waste disposed of by transfer to other premises.

F.82. These conditions provide the main basis for ensuring that the exposures to members of the public are optimised. They provide the regulatory expectation that operators should seek to ensure that discharges are not only kept as low as possible but also that all discharges are considered collectively so to understand the overall detriment that they may present. The goal-setting approach provides the means of helping ensure that operators continue to look for practicable options and other innovations which can provide further improvements in discharge reduction.

F.83. The EA and SEPA have published guidance that sets out the principles and framework for undertaking studies on optimisation and the identification of BAT [89] and BPM [90], respectively, and their roles in ensuring that ionising radiation exposures to members of the public are ALARA.

F.84. The limits on radioactive discharges are set on the basis of the 'justified needs' of the practice being conducted by the licensees, i.e. they must make a case that the proposed limits are necessary to allow safe and continued operation of the plant. This takes into account a number of factors, including:

- radiological impact on the public and the environment;
- safety;
- operational need;
- operational history of the site;
- planned future operations;
- socio-economic and cost implications;
- legal requirements;
- government policy; and
- international commitments.

F.85. The annual limits on discharges of radionuclides to the environment that are included in environmental permits or authorisations are set so that doses are well below the annual dose limit (1 mSv/year) for exposure of members of the public from discharges. Limits may be radionuclide-specific and site-specific [91]. In setting limits, the environment agencies aim to achieve reductions in discharges where possible.

F.86. The UK government has issued statutory guidance to the EA [92] that states: "Where the prospective dose to the most exposed group of members of the public from discharges from a site at its current discharge limits is below 0.01 mSv/year the Environment Agency should not seek to reduce further the discharge limits that are in place, provided that the holder of the Permit continues to apply BAT. This level of dose broadly equates to the "one in a million per year" risk of death [93] [94]. The average risk of death in the UK from naturally occurring radioactivity is estimated to be around 1 in 10,000 per year as the average background dose is approximately 2 mSv/yr.

F.87. The Statutory Guidance to the EA does not go into detail of how this should be carried out. This is to allow the EA regulatory independence and the development of detailed guidance has been left to the EA itself. The EA's Radioactive Substances Regulation (RSR) Environmental Principles (REPs) [95] are considered to be a suitable underpinning to the Statutory Guidance.

F.88. In Scotland and Northern Ireland, in line with current policy, SEPA and NIEA do not seek further reductions in discharges to comply with EASR18 and RSA93 where exposures to members of the public are optimised and less than 0.02 mSv/yr.

Dose Limitation under National Prescriptions

F.89. Following an application by an operator for a permit or authorisation for radioactive waste disposal or discharge the relevant environment agency will carry out an assessment process. The assessment will include an evaluation of whether the projected discharges will be minimised in accordance with the requirement to apply BPM/BAT and hence that the public radiation exposures will be optimised. A prospective assessment of the dose to the representative person is made by the regulator to ensure that the public's exposure through the proposed discharges would be less than the dose constraints. These constraints are set out in EPR16, EASR18 and in the Radioactive Substances (Basic Safety Standards) Regulations (Northern Ireland) 2003 [96] in Northern Ireland. They are:

- a source constraint of 0.3 mSv per annum for an individual facility which can be optimised as an integral whole in terms of radioactive waste disposals;
- a site constraint of 0.5 mSv per annum for a site comprising more than one source, e.g. where two or more facilities are located together; and
- a dose limit of 1 mSv per annum from all sources of artificial radioactivity, including the effects of past discharges but excluding medical exposures.

F.90. Retrospective assessments of doses received are also performed by the regulators to ensure that the national limit to the representative person (1 mSv) has not been exceeded.

F.91. Environmental permits held by nuclear site licence holders under EPR16 for the disposal of radioactive waste are reviewed periodically by the EA and NRW. SEPA reviews authorisations under EASR18 when it is considered appropriate to do so, although in practice this is at least once every five years. Environmental permits and authorisations for discharges are placed on public registers where they are open to inspection.

F.92. The UK Strategy for Radioactive Discharges (UKSRD09) [97] was originally published in July 2009 by the UK government and devolved administrations. The UK strategy describes how the UK implements its commitments under the OSPAR Convention for protection of the north-east Atlantic, in particular the Radioactive Substances Strategy. It applies to both the nuclear and non-nuclear sectors and includes aerial as well as liquid discharges from operational and decommissioning activities. Progressive reduction of discharges is a central goal of the way in which radioactive discharges are controlled. The UK government interprets 'progressive reduction' as a clear reduction over a number of years or a statistically significant difference between one period of years and a subsequent period to indicate a reduction. This approach allows for normal plant fluctuations, variations in nuclear reactor operations and the amount of reprocessing undertaken. Under statutory guidance issued by EA [98] and SEPA [99], the environment agencies must have regard to the strategy when determining permits and authorisations. The blue box below summarises recent progress against the OSPAR Radioactive Substances Strategy.

F.93. The outcome of the 2018 review of the 2009 strategy was published in a report entitled 'UK Strategy for radioactive discharges: 2018 review of the 2009 strategy' [100] and it concluded that satisfactory progress is being made in implementing UKSRD09.

Regulatory Environmental Radiological Surveillance

F.94. The independent monitoring and assessment carried out by the Food Standards Agency (FSA) (in England, Wales and Northern Ireland), Food Standards Scotland (FSS) (in Scotland) and the environment agencies in the UK, continue to show that radiation doses to people living around nuclear sites from permitted discharges are well below the UK and EC limit of 1 mSv/year. The most recent results of this monitoring and assessment were published in the RIFE24 (2018) report [88].

F.95. The RIFE programme includes radioactivity measurements in foods, surface and ground water, air, radiation dose rate on beaches and public occupancy areas, sediments etc. It also includes an assessment of public exposure from direct shine from sites based on measurements of doses in combination with occupancy data of the reference individual identified through habit surveys.

F.96. UK nuclear site licensees are also required to carry out their own monitoring and assessment programmes and many publish annual reports of their safety and environmental performance.

Radiation Exposure in Other Countries

F.97. Radiation exposure to members of the public in the UK must be less than the dose limits laid down in EPR16, EASR18 and IRR17. Dose estimates for those living around nuclear sites indicate that the representative persons receive doses well below the dose limit of 1 mSv per year. For example, the locations where the public received the highest doses in 2018 were near Sellafield (0.37 mSv), Capenhurst (0.16 mSv) and Amersham (0.14 mSv) [88]. Therefore, this assessment indicates that the radiation exposure to the public in other countries as a consequence of UK radioactive discharges will be much less than these dose limits.

F.98. The Euratom Treaty requires compliance with measures to monitor and report radioactivity in the environment (Articles 35 and 36) and to prevent radioactive discharges or waste disposal in one member state resulting in contamination of the environment of another member state (Article 37).

F.99. Under Euratom Article 37, Member States must submit data on their radioactive waste disposal plans to the Commission for an opinion on the likelihood of contamination of another Member State. When an EU Member State changes plans to dispose of radioactive waste or has a new nuclear facility that may increase discharges, it must make a submission to the EC for a determination on whether that change is liable to result in the radioactive contamination of the water, soil or airspace of another Member State.

F.100. UK has made appropriate submissions to the EC. Some examples of submissions made during the reporting period of this report are listed below. For all of these submissions, the EC determined that there would be no impact on EC Member States.

- Box Encapsulation Plant Product Store – Direct Import Facility (EC opinion 7 September 2018);
- Pile Fuel Cladding Silo (EC opinion 4 June 2018);
- THORP receipt and storage pond (EC opinion 4 July 2018); and
- Encapsulated Product Stores – Waste Transfer route (EC opinion 16 August 2018).

F.101. Article 37 submissions to the EC will continue to be made during the transition period. Following the end of the Transition Period, this requirement will fall away, and there will cease to be a requirement to undergo any assessment of potential transboundary effects, or international notification thereof (outside of those projects covered by the Espoo Convention). UK government is progressing work to establish an appropriate replacement process to consider an assessment of potential transboundary impacts of radioactive waste disposal plans on a domestic footing and for continuing to share relevant information with EU Member States.

Progress in Reducing Radioactive Discharges to Sea

F.102. There has been an overall reduction in discharges in the UK over the past two decades which followed the major reductions made in the 1970s and 1980s in the reprocessing sector, noting that discharges from this sector in the UK include those arising from legacy management activities including decommissioning. The UKSRD09 alongside the OSPAR Radioactive Substances Strategy aims to prevent pollution of the OSPAR maritime area (the North East Atlantic) from ionising radiation through progressive and substantial reductions of discharges, emissions and losses of radioactive substances.

F.103. In 2018, the UK published a comprehensive review of discharges, including a review of its Strategy for Radioactive Discharges [100].

F.104. The review considered discharges from across the nuclear and non-nuclear sectors, including from nuclear fuel manufacture and reprocessing, energy production and decommissioning, as well as from medical, pharmaceutical, and academic uses of radioisotopes, and discharges from the waste and incineration sector. It summarised the liquid discharge data provided by operators and provided an analysis of the trends revealed by those data. The review provided discharge figures for 2015 and forecast projections of discharges up to 2030.

F.105. The review concluded that strong progress has been made in the UK in achieving progressive and substantial reductions in radioactive discharges. The cessation of reprocessing at Sellafield will reduce discharges further. The vast majority of UK radioactive discharges from all sectors in 2015 were below the OSPAR baselines (baseline years 1995-2001), showing there is clear evidence of progress being made by the UK in contributing to meeting the objectives of the OSPAR Radioactive Substances Strategy. In about half of cases involving liquid discharges, discharges in 2015 were already below the discharge levels forecast in the UKSRD09 for 2020.

F.106. The distribution of radionuclides in coastal seas away from nuclear licensed sites in the UK continues to be monitored. This supports the UK's marine environmental policy and international treaty commitments. Government research vessels are used in the sampling programme and the results have been used to show trends in the quality of the UK's coastal seas. These surveys, together with the results of monitoring at nuclear licensed sites, contribute to the data collected by the OSPAR Commission. They also help to measure progress towards the UK government's objectives for improving the state of the marine environment.

F.107. The annual Radioactivity in RIFE report sets out the findings of the UK-wide radiological monitoring programmes carried out by the environment agencies together with the FSA and FSS, which is independent of industry. The most recent version was published in 2019 and details the findings of monitoring in 2018. This includes details of the actual annual liquid and gaseous discharges from individual permitted sites (nuclear and non-nuclear) as well as details of solid waste disposals to the LLWR. The results confirm the continuing trend of a reduction in discharges and also in total dose.

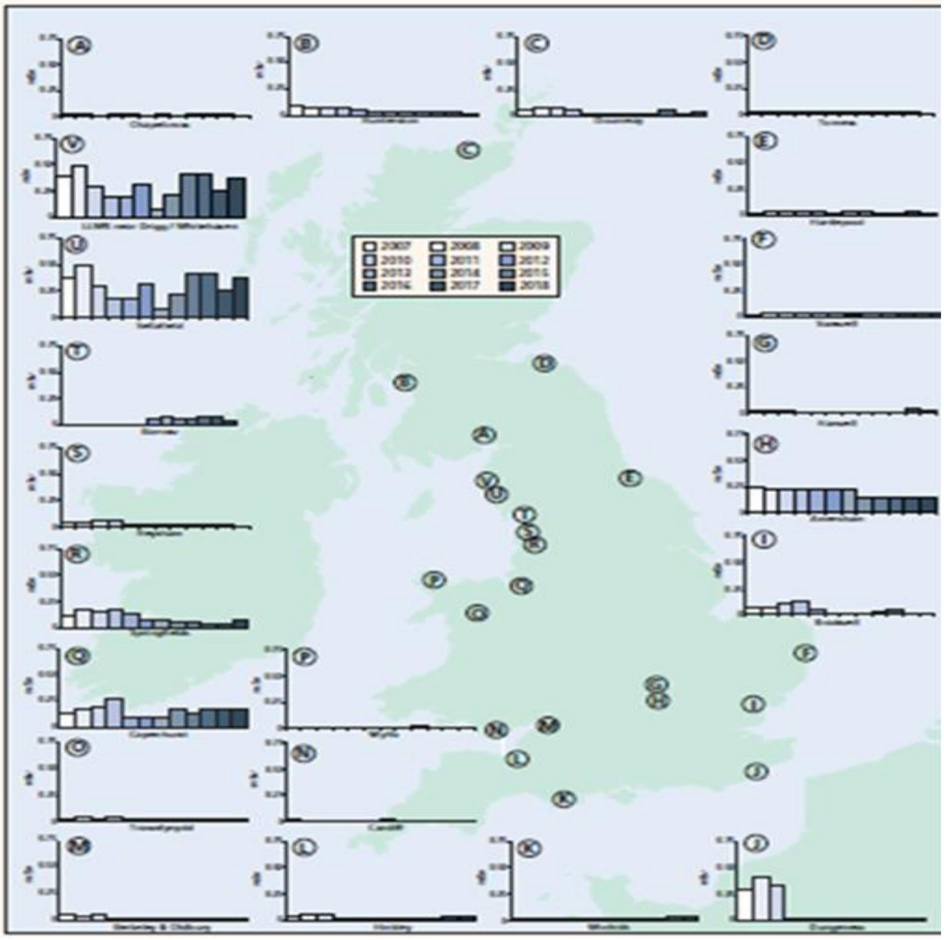


Figure 73: Total doses around the UK's nuclear sites due to radioactive waste discharges and direct radiation (2017-2018) including a time-series of annual total dose from 2007-2018

Emergency Preparedness (Article 25)

Article 25:

1. Each Contracting Party shall ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and, if necessary, off-site emergency plans. Such emergency plans should be tested at an appropriate frequency.
2. Each Contracting Party shall take the appropriate steps for the preparation and testing of emergency plans for its territory insofar as it is likely to be affected in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory.

F.108. Compliance with Article 25 is demonstrated in a way that has not substantially changed since the sixth NR. The text has been reordered and subject to updating to more concisely address the obligations set out above. In addition, a new sub-section has been included that summarises the response of the nuclear operators and regulators to the COVID-19 pandemic.

On and Off-Site Emergency Plans & Testing (Article 25.1)

F.109. The legal framework for off-site emergency preparedness and response (EP&R) arrangements is set out in the Radiation (Emergency Preparedness and Public Information) Regulations 2019 [101]. The regulations require on-site plans to be produced by the operator and off-site emergency plans to be prepared by the local authority around the site to be able to respond to all hazards capable of causing a radiation emergency from the site. The Regulations also set a periodicity for an adequate demonstration of these plans. REPPIR is supported by an ACoP and detailed guidance [102] to ensure the adequacy and consistency of emergency planning.

On-Site Emergency Plans

F.110. As well as the duties set out in REPPIR19, Licence Condition 11 (Emergency arrangements) attached to all nuclear site licences requires operators of nuclear facilities is to make and implement adequate on-site EP&R arrangements. The site operators must review and test their on-site emergency plans at least every three years, to show they are up to date and are capable of adequately responding to any radiation emergency that may arise. There is also a requirement to apply any learning from such reviews and testing to those emergency plans. For a hazardous site such as Sellafield there are many small-scale emergency exercises undertaken to test arrangements and for training purposes during the year (Sellafield runs more than 40 such exercises during the year). In addition, each year there is a large-scale emergency exercise on-site (termed a Level 1 demonstration exercise) which will be assessed by ONR for its adequacy and where deemed not to be adequate the operator may be required to repeat elements of the exercise. The operators' top-level emergency plans are approved by ONR under Licence Conditions and cannot be amended without ONR's prior approval. In producing their plans, the operators will consult with the local authorities, police and fire and rescue services, and other specified groups, who have a role or may be affected by the emergency plan. Those with a role in the emergency plan will participate in emergency exercises to become familiar with the site, its emergency arrangements, and their role.

Off-Site Emergency Plans

F.111. Off-site plans must be prepared by the local authority in consultation with the site's operator, front-line emergency responders and other specified parties. The on-site and off-site plans must be capable of working together and independently of one and other to ensure public protection. Responsibilities for preparation, reviewing, and testing (including reporting of this test) of the off-site emergency plans are also specified in REPPIR19. As with on-site plans, off-site plans must be reviewed and tested at least every three years, to show they are up to date and are capable of adequately responding to a radiation emergency that may arise. There is also a requirement to apply any learning from such reviews and testing to those emergency plans.

F.112. For certain types of installation and where there is the potential for a radiation dose to a member of the public above levels set out in REPPIR19 then detailed emergency planning zones (DEPZ) are required to be determined and put in place around the nuclear installations. The operator will undertake an assessment of all hazards capable of causing a radiation emergency, and their consequences, then based upon that assessment propose a minimum technical distance for the DEPZ to the local authority. The local authority then determines a DEPZ which can extend the minimum recommended technical distance to take account local considerations so as to be able to respond effectively to a radiation emergency. Such considerations (based on IAEA Guide GS.G.2.1: Arrangements for Preparedness for a Nuclear or Radiological Emergency) includes: local geographic, demographic and practical implementation factors; avoidance of bisecting local communities; inclusion of immediately adjacent vulnerable population groups; and benefits and dis-benefits of countermeasures. DEPZ's vary between 1km and 7kms depending on the nature and hazard from the site.

F.113. Where an extremely unlikely but more severe event could occur, a default outline planning zone (OPZ) is specified for certain categories of site. An OPZ may surround a DEPZ or, where a DEPZ is not required, directly surround the boundary of a nuclear site. OPZs, where in place, vary between 1km and 50km depending on the nature and hazard from the site. Outline planning is about identifying what protective actions may be needed at a strategic level, where those capabilities could be obtained from and the anticipated time frame over which they will become available, rather than having them in place ready to mobilise without delay (which is the case for DEPZs). Furthermore, the Statutory Guidance to the Civil Contingencies Act 2004, Emergency Preparedness, defines the requirements for preparing general emergency response plans for use when extending the off-site response to include a much larger geographical area.

F.114. The declaration of an off-site nuclear emergency at a site is the responsibility of the operator using pre-defined conservative criteria. Such a declaration would be followed immediately by a cascade notification to the first tier of emergency responders and local and national authorities.

F.115. The UK also has a modelling capability known as Joint Agency Modelling (JAM). This capability – currently being integrated into the government's response framework – builds on lessons learned from the major accident at Fukushima in 2011. JAM brings together modelling expertise from the Met Office, PHE, ONR, the environment agencies and food standards agencies in the event of an emergency to provide advice on projected doses and compare predictions against protective action criteria.

F.116. The agencies that provide a local off-site response are coordinated and led by senior personnel who would congregate at a designated off-site Strategic Coordination Centre (SCC). Their prime function is to decide on and give effect to the necessary countermeasures and protective actions to be taken to protect the public. The response by the SCC is led by a senior police officer (called the Gold Commander) and part of the role of the SCC is to provide authoritative information and advice for the public (the SCC has media briefing centres). Each organisation with responsibilities for any aspect of the emergency is represented at the SCC. These would generally include the operator, police, local authority, national health authority, local water company and the fire and ambulance services. In addition, government departments, independent regulators and other agencies would also be present.

F.117. In the event of an off-site nuclear emergency in England or Wales, the government's Emergency Operations Centre (EOC) in BEIS would be activated. In the most serios events, the UK Civil Contingencies Committee (known as COBR or sometimes COBRA) in London may also be activated. Their activation is in order to coordinate the response and take decisions at the national level. The COBR Committee would consist of representatives (Ministers or senior officials) from relevant departments and agencies. It may be chaired by the Prime Minister. Decision-making within COBR would be supported by a number of bodies and advisory groups, including a Scientific Advisory Group for Emergencies (SAGE). Figure 38 below provides a pictorial representation of the command and control arrangements in the event of an off-site nuclear emergency.

F.118. Nuclear energy is a reserved matter. Should an off-site nuclear emergency occur in Scotland the response is consistent with that in place for England and Wales. BEIS is Lead

Government Department (LGD) in the event of an emergency at a civil nuclear site in England, Wales or Scotland. Scottish Government will play a key role in supporting the response at a Scottish civil nuclear site, with off-site consequence management and recovery devolved to Scottish Government.

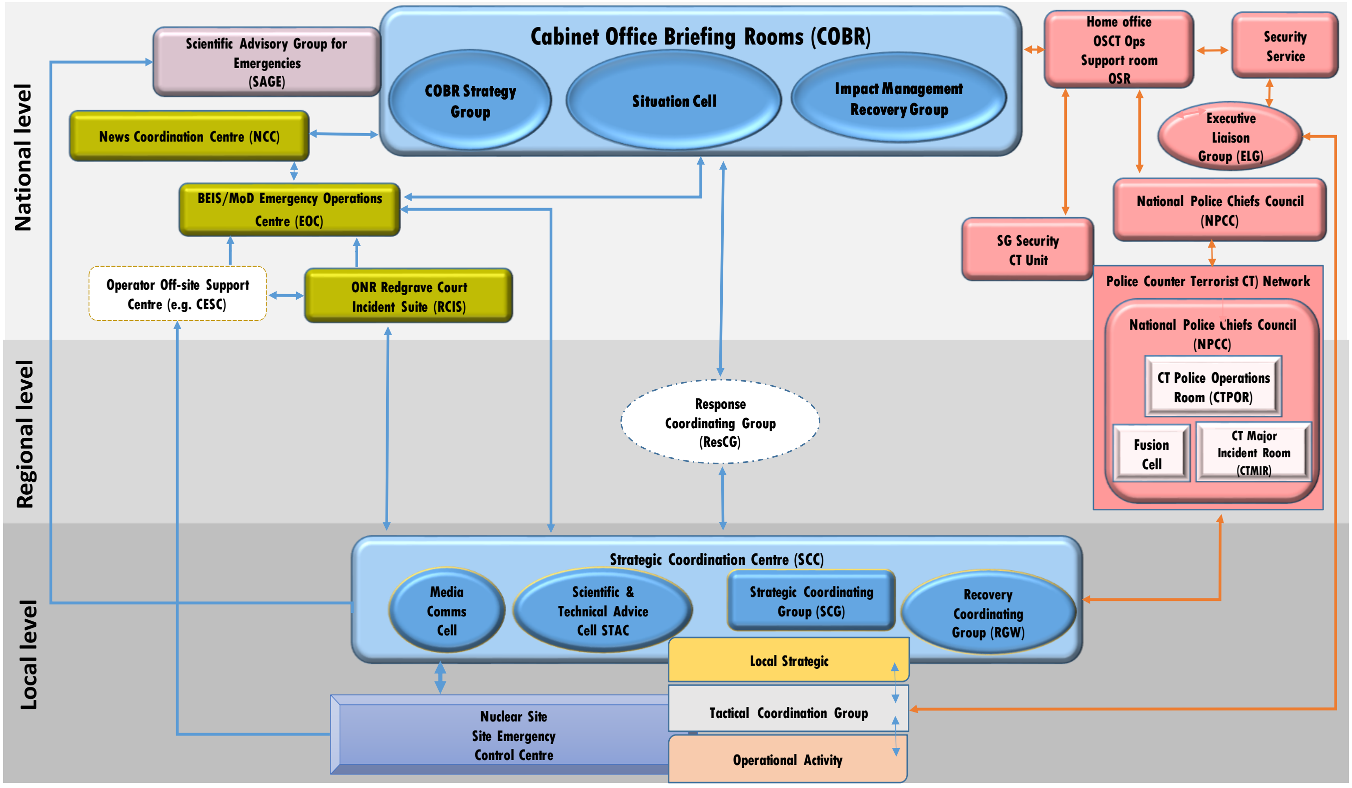


Figure 75: Emergency Arrangements Structure for England and Wales

Information to the Public

F.119. REPPIR19 provides a legal basis for the supply of information prior to a radiation emergency to members of the public around the site who may be affected by such an event, and to supply information to the public actually affected in the event of a radiation emergency. The requirements for this are placed on the relevant local authority in cooperation with the operator. As part of the local authorities' REPPIR19 off-site emergency plans, arrangements are included that ensure that members of the public affected by a nuclear emergency receive prompt and appropriate information. The principal means of communication with the public outside the immediate vicinity of the affected site would be through public media channels.

Testing of Emergency Arrangements

F.120. On and off-site emergency arrangements are tested regularly under three categories of emergency exercises; termed as Level 1, 2 and 3, in summary these are as follows:-

- Level 1: Annual exercises; undertaken to demonstrate the on-site EP&R arrangements with some elements of the off-site arrangements included e.g. coordination with emergency responders. Over a longer period of time all aspects of the site emergency plan are tested;
- Level 2: Three yearly exercises; aimed primarily at testing the adequacy of the arrangements that have been made by the local authority to deal with the off-site aspects of the emergency, particularly the functioning of the SCC where organisations with responsibilities or duties during a nuclear emergency also exercise their functions; and
- Level 3: A national exercise; from the ongoing programme of Level 2 exercises, one is selected as a Level 3 exercise to rehearse, not only the local aspects, but also wider central government response arrangements, including the exercising of the various government

departments and agencies attending the COBR (for England and Wales), or the SGoRR (for Scotland). Aspects of BEIS's international liaison arrangements, including the process on notification, are routinely tested during the Level 3 exercises.

National Oversight

F.121. BEIS is the LGD for national policy on emergency preparedness for any emergency with off-site implications at civil nuclear sites in England, Wales or Scotland. BEIS is also responsible for providing strategic national direction on policy impacts, overseeing national response and managing international liaison in response to an emergency. As described above, for any emergencies at civil nuclear sites in Scotland, Scottish Government provide a key role in supporting the BEIS response. National emergency arrangements are based on generic civil contingency arrangements as far as possible with the approach to ensure that the response is seamless at each level and across the UK.

F.122. The Nuclear Resilience Coordination Committee (NRCC) is the national programme set up to direct the UK's approach to responding to a nuclear emergency. The NRCC aims to ensure that the UK's planning for response to a nuclear emergency at home or overseas is effective, proportionate and sustainable.

F.123. The government has published Nuclear Emergency Planning and Response Guidance (NEPRG) [103] to assist local planners, cross-government departments, devolved administrations and agencies carry out nuclear emergency planning to enable them to write effective emergency plans. The guidance describes the arrangements that have been developed for responding to an emergency in the UK over a number of years.

International Notifications of a UK Emergency

F.124. For an emergency at a nuclear installation in the UK, BEIS would take the responsibility for notifying other countries and initiate requests for international assistance. Under existing early notification conventions, BEIS would inform the European Union, the IAEA, and countries with which the UK has bilateral agreements and arrangements, about the accident and its likely course and potential effects.

Response to Emergencies in Overseas Territories (Article 25.2)

F.125. BEIS is the lead government department for coordinating the response to an overseas nuclear emergency that affects the UK. The UK has signed a number of international agreements covering exchange of information in the event of a nuclear emergency. The UK is a member of IAEA's global assistance mechanism in the event of a nuclear emergency, Response and Assistance Network (RANET). The UK's Radioactive Incident Monitoring Network (RIMNET) is the contact point for inward and outward notifications under these arrangements. RIMNET includes a nationwide network of 96 fixed gamma dose rate monitors, with a further 107 available through mobile communications that provides a secondary alert mechanism in the event of non-notification. It also provides access to forecasts of the areas of the UK likely to be affected by any overseas nuclear accident based upon Meteorological Office data and models. There are plans to upgrade RIMNET within the next 2 years to a more modern platform called the Radiological Response Emergency Management System (RREMS).

F.126. The national response plan provides arrangements for dealing with an overseas nuclear emergency. This includes BEIS maintaining contact arrangements and duty officers that ensure the UK can be notified of an emergency at any time. The UK routinely takes part in emergency exercises with other countries to test the emergency arrangements should there be a nuclear emergency in another country that has the potential to affect the UK.

Response to the COVID-19 Pandemic

F.127. In early March 2020, the Prime Minister chaired a meeting of COBR to decide on actions to be taken in response to the threat posed by the COVID-19 Pandemic. Subsequently government advice was provided to the nation, which was regularly reviewed and updated. To maintain operational safety, nuclear facility operators implemented their pre-existing pandemic response and business continuity arrangements. Non-essential activity on site was temporarily halted, and staff not required on site for operational safety or to maintain security worked from home where they could comply with government guidance.

F.128. The result was that during March and early April 2020 the majority of non-essential radioactive waste management facilities and the Magnox spent fuel reprocessing facility at Sellafield were progressively shut down and put into a quiescent interim safe state. The exceptions were for new nuclear fuel production and transport of new and spent fuel to ensure that the operating nuclear power stations could continue to generate electricity; the LLWR also remained operational, receiving some containers of LLW for disposal and consigning some waste into the supply chain. All non-essential personnel were sent home and decommissioning and radioactive waste retrieval and handling operations were temporarily halted. Minimal staffing levels were maintained at the sites mainly for security, maintenance, surveillance and environmental monitoring duties. The effect of absenteeism was monitored by the operators, ONR and the environment agencies, to ensure, amongst other things, that sites' emergency arrangements were not compromised, with capacity to call personnel to site in the event they were needed. In addition, the supply chain was kept under review to see that essential operations would not be significantly compromised. ONR and the environment agencies suspended routine inspections and face-to-face meetings at the sites to comply with the government guidance but were in regular contact with the operators to monitor the situation and make regular reports into government on any emerging issues to be addressed. ONR carried out remote interventions using video-/tele-conferencing to gain assurance that the licensees were maintaining safe operations and meeting their statutory requirements, and inspectors attended site to carry out investigations in relation to any safety-related incidents as appropriate.

F.129. Non-nuclear sites were similarly affected, and the environment agencies worked with other regulators to understand the implications for activities at non-nuclear sites involved in the management and disposal of radioactive wastes and in ensuring contact with all operators responsible for continued management of high activity sealed radioactive sources. The COVID-19 pandemic also impacted on the independent environmental monitoring programmes undertaken and reported on by the environment agencies and Food Standards Agencies (as reported in RIFE). Consideration is consequently being given to addressing any shortfalls through additional monitoring later in the post once restrictions are lifted. Recognising that this could in due course impact on the UK reporting data to the EC the UK government has sought advice from the EC on its expectations for reporting impacted by this period.

F.130. In supporting industry, both nuclear and non-nuclear, the ONR, EA, SEPA, NIEA and NRW published a number of time-limited regulatory position statements (RPS) or other information enabling a more flexible approach for operators to continue to comply safely during the period. The regulatory positions are available at the following links:

- ONR – COVID-19 (Coronavirus) – ONR Position;
- EA – Regulatory response to Coronavirus;
- SEPA – Our regulatory response to Coronavirus;
- NIEA – Regulatory response to Covid19; and
- NRW – Our response to the coronavirus pandemic.

F.131. During the period of shutdown, the operators commenced planning on how to make a systematic safe phased return to work, while still complying with the guidelines on social distancing, hand hygiene etc. On the 10th May the Prime Minister announced revised government guidelines which prompted operators to commence a phased return to work. This period lasted several months and involved operators revising their arrangements to continue to meet the government's guidelines aimed at suppressing the incidence of COVID-19. In response to government's safer working guidance, sites have commenced the re-start of non-essential activity that was temporarily halted.

Decommissioning (Article 26)

Article 26: Each Contracting Party shall take the appropriate steps to ensure the safety of decommissioning of a nuclear facility. Such steps shall ensure that:

(i) qualified staff and adequate financial resources are available;

(ii) the provisions of Article 24 with respect to operational radiation protection, discharges and unplanned and uncontrolled releases are applied;

(iii) the provisions of Article 25 with respect to emergency preparedness are applied; and

(iv) records of information important to decommissioning are kept.

F.132. Under this Article, compliance with the JC is demonstrated in a way that has not substantially changed since the sixth UK NR.

F.133. The NDA through its SLCs, is responsible for ensuring decommissioning and clean-up of most of the UK's civil nuclear facilities (excluding the EDF(NG) owned operating reactors), which includes Sellafield and 16 other sites. This includes the provision of adequate human and financial resources, as required by LC36.

F.134. The safety of decommissioning is subject to the standard LCs that apply throughout a facility's lifecycle. A licensed site cannot be de-licensed until the operator can satisfactorily demonstrate to ONR there is 'no danger' from ionising radiation from any Article remaining on the site.

F.135. Under LC35 operators must make and implement adequate arrangements for the decommissioning of any plant which may affect safety and include adequate decommissioning programmes. The ONR has the power to direct a licensee to commence decommissioning, in the interests of safety.

F.136. The operator's primary objective through decommissioning is to secure a progressive and systematic reduction in radiological hazards, achieved in a manner that optimises the protection of individuals, society and the environment. ONR and the environment agencies expect the operators to have coherent plans to decommission their facilities, targeted at ultimate removal of all significant radiological hazards wherever that is reasonably practicable. The relevant factors licensees should consider in determining their priorities for decommissioning are explicit in government policy and repeated in ONR's decommissioning-related SAPs and the EA's Radioactive Substances Regulation Environmental Principles (REPs).

F.137. The aspects of decommissioning under Article 26 (ii), (iii) and (iv) are set out in more detail in the relevant sections of this report under Articles 22, 24 and 25, and for information on decommissioning related records under Article 23.

Steps to Safe Decommissioning: Some UK experience

F.138. It has been recognised by operators and regulators that in some circumstances decommissioning may require a temporary increase in risk in order to secure a reduction in hazard that gives an overall safety benefit in the longer term (e.g. a need to isolate protection systems in order to undertake invasive clean-up work). Such an approach requires rigorous substantiation by the licensee, including a demonstration that risks at each stage of the activity are maintained ALARP.

F.139. The advanced age of some UK nuclear facilities implies that decommissioning can require licensees to manage uncertainties, involving factors such as: the as-built status of plant or structures; incomplete radioactive inventories; and unknown effects of long-term ageing. Regulatory expectations for the management of uncertainty are based on the precautionary principle and embedded in the UK risk management framework.

F.140. The nature of some decommissioning tasks may necessitate a greater emphasis on administrative controls to deliver adequate margins of safety. Decommissioning may also give rise to elevated conventional safety risks, for example work in areas with restricted access, work at height, or in confined spaces. One hazardous aspect of the work in the UK that was underestimated is removing asbestos. This has proved to be both difficult and very expensive as the legal controls are very stringent. In such circumstances, the regulators expect the operators to carry out risk assessments that recognise all relevant sources of risk and implement an adequate range of risk-reduction measures.

F.141. Some decommissioning challenges revolve around the fact that many facilities to be decommissioned were designed and built several decades ago and these facilities were never designed with decommissioning in mind. This makes the task more challenging particularly as safety standards have changed over time. In addition, with time, knowledge of the facilities has the potential to be lost or degraded.

F.142. An increasingly difficult challenge is whether to spend time and money upgrading these facilities prior to decommissioning, or to tolerate the risk of undertaking decommissioning operations on degrading plants. The more decommissioning is deferred, the greater this problem becomes, potentially increasing the cost and duration of decommissioning programmes.

F.143. A specific example is decommissioning of plants with a high alpha and plutonium burden during the operational phase. Insufficient or foreshortened POCO phase may lead to considerable alpha contamination within facilities which has to be dealt with throughout the decommissioning phases. Some facilities were handling plutonium liquors on a regular basis during reprocessing operations, leading to a considerable alpha burden, even after long-term plant washouts.

Section G/H – Safety of Spent Fuel, Reprocessing and Radioactive Waste Management

GH.1. As in previous NRs the UK considers that it is not necessary to have two separate sections related to the identical obligations under Articles 4 and 11 for the safety of spent fuel and radioactive waste management. Therefore, sections G and H are combined, and where there are any differences these are indicated in the text.

General Safety Requirements (Articles 4 and 11)

Articles 4 and 11: Each Contracting Party shall take the appropriate steps to ensure that at all stages of [spent fuel] [radioactive waste] management, individuals, society and the environment are adequately protected against radiological [and other] hazards.

In so doing, each Contracting Party shall take the appropriate steps to:

i) ensure that criticality and removal of residual heat generated during spent fuel / radioactive waste management are adequately addressed;

ii) ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;

iii) take into account interdependencies among the different steps in spent fuel / radioactive waste management;

iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;

v) take into account the biological, chemical and other hazards that may be associated with spent fuel / radioactive waste management;

vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;

vii) aim to avoid imposing undue burdens on future generations.

GH.2. Under these Articles, the means by which the UK demonstrates compliance is substantively unchanged since the sixth UK NR.

Adequate Protection of People, Society and the Environment

GH.3. The UK has worked with ionising radiations and operated nuclear facilities for many decades in a way that ensures adequate protection of individuals, society and the environment against radiological hazards. This is achieved through legally responsible operators complying with the UK's comprehensive legal framework that adopts all relevant internationally agreed standards and implementing arrangements for complying with all relevant legislation. Furthermore, they are adequately resourced to underpin safe operations, understand the hazards and risks they are dealing with, and are committed to the adoption of relevant good practice through continuously seeking and making reasonably practicable improvements to safety and environmental protection. Many sections of this report describe aspects of the UK approach in more detail, together with recent case studies providing practical example of the approach being taken.

GH.4. The handling treatment, storage and reprocessing of spent fuel, and the management of radioactive waste are all prescribed activities under the NIA65. As a result, organisations managing radioactive waste and spent fuel on a specified site must hold a nuclear site licence granted by ONR, and an environmental permit from the relevant environment agency.

Criticality, Shielding, Containment and Removal of Residual Heat removal (Articles 4/11(i))

GH.5. Assessment of the risk associated with criticality and the need for shielding, containment and the removal of any residual heat being generated are all considered as part of the licensees' safety cases (LC14 & LC23). The implementation of the safety case is through a combination of the design of the facility and the identification of limits and conditions in the interests of safety, which for plant operators are set out in operating rules (LC23) and operating instructions (LC24). ONR assess the adequacy of the operators' safety cases prior to granting permission for moving from one stage of the lifecycle to another or for safety significant associated work activities to take place. In making its decisions ONR judges the adequacy of the licensees' safety case and other arrangements, through comparing them with its published SAPs [54] and supporting TAGs [55].

Minimising the Generation of Radioactive Waste (Articles 4/11(ii))

GH.6. As set out in the sixth UK NR, the UK has successfully applied the waste management hierarchy which continues to provide clear benefits in reducing the overall amount of all wastes generated. The implementation of the hierarchy was recognised at the sixth JC RM where the UK was given a Good Practice for its approach.

GH.7. There is a legal duty (LC32) on all operators to minimise, so far as is reasonably practicable, the rate of production and total quantity of radioactive waste accumulated on their sites. In addition, environmental permit requirements seek to minimise the disposal of radioactive waste in all of its forms (solid, gaseous and liquid).

Interdependencies in Spent Fuel and Radioactive Waste Management (Articles 4/11(iii))

GH.8. The NDA is responsible for decommissioning and clean-up of the UK's civil nuclear waste across the 17 sites it owns, which includes Sellafield and the LLWR site. The NDA's strategy recognises the interdependencies between the site licence companies who run its sites and for transport of spent fuel to Sellafield and other movements of radioactive waste.

GH.9. The regulators have encouraged the operators to produce and use RWMCs, which are aimed at providing the complete demonstration of the optimised management of solid radioactive waste streams that cannot necessarily be demonstrated in a coherent way through examination of individual facility safety cases and environmental documentation. A RWMC usually includes the key elements of managing waste, including any interdependencies between all steps in generation and management of radioactive waste management for example how the radioactive waste meets the relevant requirements to enable its transport and disposal.

Protection of Individuals, Society and the Environment (Articles 4/11(iv))

GH.10. See subsection Adequate Protection of People, Society and the Environment, above

Associated Biological, Chemical and Other Hazards (Articles 4/11(v))

GH.11. The biological, chemical or other hazards associated with the handling, treatment, storage and, where appropriate, reprocessing of spent fuel and radioactive waste are subject to general health and safety law and associated specific regulations such as the Control of Major Accident (COMAH) Regulations, the Control of Substances Hazardous to Health (COSHH) Regulations and the Control of Asbestos Regulations 2012, and the non-radiological controls set out in environmental permits. Through taking a coordinated approach to regulation, ONR and the environment agencies ensure that the licensee considers all significant non-radiological chemical and biological hazards that could impact on the workers, the public and the environment, and not simply those related to the radioactive hazard present. Where there are other conventional industrial hazards that may affect spent fuel and radioactive waste safety, then on licensed nuclear sites ONR is the regulatory body responsible for enforcing compliance with any legal duties placed on the operators.

Avoiding Undue Impacts and Burdens on Future Generations (Articles 4/1(vi & viii))

GH.12. It is government policy to ensure that any impact from today's activities on future generations, are properly considered, so that we don't place undue burdens on our descendants. The concept of inter-generational equity is an important part of the UK's strategy for sustainable development [104].

GH.13. There is a policy of prompt nuclear decommissioning taking into account all relevant factors [23]. Some of the relevant factors are: the size and scale of the challenge, particularly at Sellafield; the constraints on funding and capacity; and the absence of an operational GDF. It is just not possible to do all of the work simultaneously. The NDA estimates that it will take more than a century to clean up the major part of the UK's civil nuclear legacy at an estimated cost of more than £131 billion (discounted cost) using current techniques.

GH.14. As a result of the above position the policy allows for decommissioning to be deferred or phased over many decades to accrue some safety benefits from radioactive decay. There are examples of both prompt decommissioning and deferred dismantling being undertaken in the UK. The NDA owned sites at Winfrith, Harwell and Dounreay are being restored to brownfield status where they can be reused. In contrast the Bradwell site entered an extended period of quiescence termed 'Care and Maintenance' in November 2018. The approach currently being taken is to decide on the most appropriate lifetime decommissioning plan on a site-by-site basis.

GH.15. In addition to the NDA sites, other licensed nuclear sites are being decommissioned and cleaned-up to the point where they can be delicensed for unrestricted use or for identified potential future uses. In December 2019, the former GE Healthcare radiopharmaceuticals site in Cardiff, Wales had its licence revoked by ONR. Within the next few years, it is anticipated that the Imperial College research reactor and the other GEHC site at Amersham will be decommissioned and cleaned-up for delicensing.

Existing Facilities and Past Practices (Articles 5 and 12)

Article 5: Each Contracting Party shall take the appropriate steps to review the safety of any spent fuel management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility.

Article 12: Each Contracting Party shall in due course take the appropriate steps to review:

i) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility;

ii) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention.

GH.16. Under these Articles, the means by which the UK demonstrates compliance is substantially unchanged since the sixth NR.

Existing Facilities

GH.17. The operators with responsibility to safely operate existing facilities on UK licensed nuclear sites have a legal duty to comply with the requirements of all applicable health, safety and environmental protection laws. Operators have systems for feedback of experience both on their sites and through access to learning from other external organisations, both in the UK and internationally. Such feedback is acted upon, where appropriate, and results in improvements to safety being made within facilities. In addition, one of the standard licence conditions (LC) attached to a site licence is LC15, which requires the operators to make arrangements for the periodic and systematic review of safety (Periodic Safety Review - PSR). This requires the licensee to review, in a defined period (usually every 10 years) or potentially where there is a substantial change in the operational state of the site such as entry into a C&M state, the safety cases for its spent fuel management and radioactive waste management facilities. The overall purpose of the decennial PSR is to determine:

- the extent to which the extant safety case remains valid;
- the extent to which the facility and safety case meet modern standards and practices;
- the adequacy of the arrangements in place to maintain safety until the next PSR or the end of life; and
- any safety improvements to be made to resolve safety issues.

GH.18. As a result of undertaking a PSR the operator will identify any reasonably practicable improvements to safety and put in place a plan of work to make the necessary improvements. ONR will independently assess and judge whether the PSR is adequate.

GH.19. In addition, the environmental permits issued to licensed nuclear sites for radioactive discharges and the disposal of radioactive waste, by the environment agencies require the regular review of these permits and authorisations.

Intervention for Past Practices

GH.20. The early development stages to enable the use of nuclear power to generate electricity began in the late 1940s, and the first power station at Calder Hall (now part of the Sellafield site) was connected to the electricity grid in 1956. In 1957 the UK suffered its worst nuclear accident, a fire in Windscale Pile 1 (also now part of Sellafield). This was retrospectively rated as INES Level 5 and led to the rigorous current licensing regime being brought into effect through the 1960 Nuclear Installations Act. The standards of design, construction, record-keeping, operational safety and environmental performance of the first-generation facilities were much lower than the modern standards in place today. In particular, the longer-term management of radioactive waste and future decommissioning of these facilities was not properly considered. Some of these decades old degrading facilities have resulted in the significant challenges for the UK, particularly on the Sellafield site. For the purposes of this report 'past practices' are being interpreted as activities that did not take place on any of the 36 licensed nuclear sites. The remainder of this sub-section will outline where radioactive substances were used in past practices for industrial, medical, research and other purposes that may have led to, or in future may need, specific interventions for radiological protection of the public.

GH.21. Radioactive substances have been used in the UK for a wide variety of purposes for well over a hundred years, but most have only been subject to regulation since 1963, the year in which the 1960 Radioactive Substances Act came into force. Historic contamination of land by radionuclides from past practices has occurred, in many cases due to a lack of understanding of the hazards posed by radioactive materials at the time. Industrial activities have involved the use of materials containing radioactivity in a variety of different contexts: (a) where radioactive materials have been employed for their radioactive properties (for example, luminising works); (b) where radioactive properties are incidental in materials that are used for their non-radioactive properties (for example, gas mantle production); and, (c) where radioactive materials have been inadvertently handled, or escaped accidentally (for example, lead mining).

Little information is available on the scale of radioactive contamination outside of nuclear sites. Where historical information is available it is not comprehensive. A regime for the regulation of radioactive contaminated land was introduced in 2006 through extension of Part 2A of the Environmental Protection Act 1990 (EPA90).

GH.22. The objectives of the radioactive contaminated land regime are to provide a system for the identification and remediation of land where contamination is causing unacceptable risks to human health. The overarching objectives of the government's policy on radioactive contaminated land and the Part 2A regime are to:

a. identify and remove unacceptable risks to human health;

b. seek to ensure that radioactive contaminated land is made suitable for its current use;

c. ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of sustainable development.

GH.23. The radioactive contaminated land regime only covers land where radioactivity is present as a result of a past practice or activity or as a result of the after-effects of an emergency. It does not apply to current practices and natural background radiation.

GH.24. Statutory guidance [105] relating to the radioactive contaminated land regime for England was published in 2018; such guidance had been published for Scotland and Wales some years previously. The guidance for England explains how local authorities should implement the regime, including how they should go about deciding whether land is 'contaminated land' in the legal sense of the term. It also elaborates on the remediation provisions of Part 2A, such as the goals of remediation, and how the EA (as the enforcing authority for radioactive contaminated land) should ensure that remediation requirements are reasonable. The Guidance also explains specific aspects of the Part 2A liability arrangements, and the process by which the EA may recover the costs of remediation from liable parties in certain circumstances. In Scotland, the contaminated land regime works differently as it is SEPA rather than the local authority who decides whether the land is 'contaminated land' for the purpose of the legislation.

GH.25. For land to be determined as radioactive contaminated land, a 'significant contaminant linkage' must be present. A contaminant linkage comprises a radioactive contaminant and a human receptor, with a pathway capable of linking the two. All three elements need to occur on site for a contaminant linkage to exist. The contaminant linkage becomes 'significant' if it results in harm to human health, or there is significant possibility of such harm occurring. This has been defined as a dose that exceeds one or more of the following:

- an effective dose of 3mSv per year;
- an equivalent dose to the lens of the eye of 15mSv per year; or
- an equivalent dose to the skin of 50mSv per year.

GH.26. In addition to humans, the Radioactive Contaminated Land (Scotland) Regulations 2007 include water as a receptor and include 'significant pollution of the water environment' as part of the definition of 'radioactive contaminated land'. The regulations also identify that radioactive contaminated land exists for:

- terrestrial biota or plants, with a dose rate from lasting exposure of more than 40microGy per hour; or
- aquatic biota or plants, with a dose rate of more than 400microGy per hour.

GH.27. If land is 'determined' as radioactive contaminated land, intervention will be carried out to remediate the land, provided this is justified, i.e. when the benefits of reducing the detriment outweigh the harm and costs (including social costs) of taking action. For an intervention to be optimised, the chosen action must maximise the difference between the benefits produced by the reduction in detriment and the harm or costs of achieving it.

GH.28. EPA90 does not apply in Northern Ireland. Parallel regulations were introduced there in 2006 and 2007 (Radioactive Contaminated Land Regulations (Northern Ireland) 2006 and amendment in 2007).

GH.29. The ONR has powers under NIA65 to regulate land contaminated with radioactivity within the boundaries of licensed nuclear sites. For this reason, the requirements of Part 2A of EPA90 [106] do not apply to land contaminated with radioactivity on these sites.

Siting of Proposed Facilities (Articles 6 and 13)

Articles 6 and 13:

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed spent fuel or radioactive waste management facility:
   i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;
   ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment;
   iii) to make information on the safety of such a facility available to members of the public;
   iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.
2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 4.

GH.30. Under these Articles, the means by which the UK demonstrates compliance is substantially unchanged since the sixth NR.

GH.31. As indicated in the sixth UK NR and at the time of the sixth RM, the UK has no immediate plans to construct any new spent fuel management facilities or radioactive waste management facilities on a new nuclear site. All of the UK's civil derived higher activity radioactive waste and spent fuel is contained within facilities on the existing licensed nuclear sites.

GH.32. In the case of the UK's only operating PWR at Sizewell B, all of the spent fuel generated over the operational lifetime of the station will be stored on site in dedicated facilities, until a decision is taken regarding its future use. If it is subsequently classified as waste, it will be disposed of in a future GDF. A similar approach is being taken at the Hinkley Point C site where construction of a new PWR nuclear power station is underway. There are outline proposals to build PWRs at Sizewell C and Bradwell B in due course. It is anticipated that a similar approach for spent fuel storage will be taken, subject to final agreement of proposals for these and any further new build projects.

GH.33. As part of some nuclear sites' lifetime decommissioning plans there will be a need to construct some new facilities to handle, treat and store radioactive waste. These will be constructed to modern standards and subject to the well-established regulatory regime as outlined in other sections in this report.

Planning Permission

GH.34. Any organisation wishing to construct any type of spent fuel management or radioactive waste management facility on a new site in the UK must obtain planning permission. This is normally granted by the local planning authority. Planning permission for nationally significant infrastructure projects, i.e. large scale developments such as construction of new nuclear power stations or a GDF (including deep boreholes necessary to assess the suitability of potential sites), is granted by the Planning Inspectorate in a type of consent known as a development consent. The organisation would also need a nuclear site licence to operate the facility and an environmental permit (for radioactive discharges and any disposal activities).

GH.35. Proposals for spent fuel management facilities or reprocessing facilities must be accompanied by an assessment of the environmental impact of the proposed development if required by the relevant Environmental Impact Regulations. The ONR provides advice to local planning authorities on any planning applications for developments around nuclear sites [107]. The advice provided seeks to limit the radiological consequences to members of the public in the event of a nuclear emergency.

Nuclear Site Licensing

GH.36. NIA65 requires that a licence is granted by ONR before any site is used for installing or operating a nuclear installation. Only a corporate body, such as a registered company or a public body can hold a licence and the licence is not transferable. The type of installations that require licensing are those prescribed in the Nuclear Installations Regulations 1971; further information can be found in Section E – Legislative and Regulatory System. Site evaluation will form part of the initial licensing process to demonstrate that the proposed site is acceptable for such an installation in respect of its impact on the local population and environment. For new facilities on existing sites, the licensee's safety case is required to show that the new facility will not adversely affect the characteristics and safety of the existing site.

Public Consultation

GH.37. The proposal for any significant new spent fuel, reprocessing or waste management facility on a nuclear site would normally be subject to a public inquiry. The ONR would not license such a facility until the completion of the public inquiry and a ministerial decision made under planning law. The ONR's licensing process would run concurrently with a public inquiry to avoid unnecessary delays. However, the ONR would not grant a licence in advance of a decision on planning consent. Note that radioactive waste disposal is not a prescribed activity and therefore is not currently subject to the licensing regime, albeit UK government is putting arrangements in place to ensure ONR will be able to license a GDF.

Environmental Permits for Radioactive Waste Disposal

GH.38. Any new spent fuel, reprocessing or waste management facility, whether on or off a nuclear site, in England, Wales or Northern Ireland would require prior permitting or authorisations under EPR16 or RSA93 to dispose of radioactive waste, including solid waste, and aqueous and gaseous discharges. A new facility in Scotland would require prior authorisation under EASR18 for the management of radioactive waste. Such disposals would not be permitted unless appropriate dose limits and constraints and other requirements, such as keeping public radiation exposures optimised were met. As part of their process for the consideration of any application relating to a new spent fuel, reprocessing or waste management facility, each of the environment agencies undertake notification of relevant statutory consultees as well as public consultation upon receipt of an application, as well as further consultation relating to their determination and proposed decision relating to an application.

GH.39. If required, the EA, NRW, SEPA or NIEA would give evidence to a public inquiry as to whether a proposed nuclear installation or other radioactive waste management facility could be granted an environmental permit under EPR16, EASR18 or RSA93.

Hazards

GH.40. For spent fuel, reprocessing or waste management activities on most nuclear sites, the operators would be expected to submit to ONR a safety case to demonstrate the suitability of the site and its compliance with the ONR's siting criteria. Generally, the safety case would address the impact of the facility on the surrounding area from routine operations and fault conditions. Typically, the licensee would need to consider details of present and predicted population around the site, and the local infrastructure such as housing, schools, hospitals, factories etc. The factors the ONR would assess would include: emergency planning; external hazards such as flooding; seismicity; and other geological factors. The ONR would assess this information in the safety case using the siting criteria in the SAPs.

GH.41. Consideration is also given to any undue effects the presence of the nuclear installation might have on the local environment, for example, the environmental effects of radioactive discharges.

GH.42. For proposals relating to the development of any radioactive waste disposal facility, whether at a nuclear or non-nuclear site, the prospective permit holder would be required to submit to the relevant environment agency an application including an environmental safety case to demonstrate the suitability of the site and planned arrangements for the management of the wastes in accordance with the environment agencies published Guidance. This includes Guidance on Requirements for Authorisation (GRA) for near surface disposal [57] and for geological disposal [108], as well as the GRR guidance [35] as appropriate.

Emergency Arrangements

GH.43. As stated above, one of the key factors in assessing the suitability of a site for a nuclear installation is the impact of a possible nuclear emergency on the population in the area. Although nuclear installations in the UK are designed and operated to high standards, the licensees are legally required to have in place on and off-site emergency plans. Further information can be found under the response to Article 25 in Section F - Other General Safety Provisions of this report.

Topography

GH.44. The siting of the nuclear installation will require consideration of the topography of the area that might affect the dispersion of the radioactivity discharged from the site in normal operation or released in the event of an accident. In addition, aspects of the topography of the area around the site that may affect the movement of people and goods are identified, and their effect on the safety of the plant is examined. This examination determines whether the topography and road, rail and sea could create difficulties if it became necessary to evacuate people from the area around the plant.

Information Available to the Public

GH.45. The planning application process undertaken either by a local planning authority or the Planning Inspectorate (for new nuclear build or GDF development) provides an opportunity to inform and obtain views from the public in relation to any proposals for the construction and operation of a spent fuel, reprocessing or waste management facility whether on a nuclear site or elsewhere. In addition, the environment agencies will each consult on a developer's application for the permitting or authorisation of the disposal of radioactive waste at or from a site. ONR, the EA, NRW and SEPA have corporate policies to ensure that public information is available in an open and transparent manner subject to the requirements of the Freedom of Information Act 2000 (FOIA2000) [109] and the Freedom of Information (Scotland) Act 2002 [110]. Regulators in England, Wales and Northern Ireland also have duties under the Environmental Information Regulations 2004 made under the FOIA2000, which implement EC Directive 2003/4/EC on public access to environmental information. Similar regulations are in place in Scotland with the Environmental Information (Scotland) Regulations.

Maintaining the Continued Acceptability of the Site

GH.46. Once a nuclear site is in operation, the ONR must be satisfied that the characteristics of the site are preserved to ensure the continued effectiveness of the on-site and off-site emergency plans, and that the general radiological siting criteria continue to be met. The ONR monitors this through the local authority land use planning controls. This requires the ONR to be consulted on developments within a specified radius of the site. Continued re-evaluation by the licensee of the external hazards and of the emergency plans is also required. Guidance on re-evaluation of the specific demographic requirements on siting is given to the ONR Inspectors in the SAPs.

GH.47. UK Government [111] and Scottish Government [112] have issued guidance which gives advice on the exercise of planning control over hazardous development and over development in the vicinity of hazardous installations.

GH.48. These circulars provide guidelines for the types of development in the vicinity of hazardous installations on which HSE should be consulted in relation to development in the vicinity of hazardous installations covered by the Regulations for Control of Development (Hazardous Substances) [113]. ONR is a statutory consultee for those hazardous installations that are also GB nuclear sites. The ONR has non-statutory arrangements, operated under the same administrative arrangements, to be consulted by local authorities in the case of planning applications in the vicinity of all other types of nuclear installations. The ONR Inspectors assess such planning applications to determine:

- whether a proposed development would raise the population to near the maximum guidelines set out in the government's siting policy for nuclear installations;
- whether the external hazards recognised in the nuclear safety case include the hazard from a proposed hazardous installation, or alternatively whether a newly introduced hazard can be incorporated whilst continuing to demonstrate adequate safety;
- for a proposed development within the nuclear licensed site, whether the licensee has made a satisfactory safety case for the proposed development and for any existing licensable activities on the site that it would impinge upon, and whether the proposed activity is suitable for a nuclear licensed site;
- for a proposed development within the detailed emergency planning zone (where applicable), the ONR refers the application to the local authority responsible for the off-site emergency plan, who then liaises with the responsible bodies under the plan, to find out:
- whether the development can be incorporated into the emergency plan; or
- whether the emergency plan could be modified to incorporate the development.

GH.49. The ONR requires assurance that the impact of developments in the immediate vicinity of a nuclear installation can be accommodated in the emergency preparedness arrangements, to satisfy the requirements of the REPPIR 2019 requirements and LC11 (Emergency arrangements).

GH.50. The ONR also engages with local planning authorities with regard to the allocation of land for development as set out in their Local Plans.

GH.51. Licensees and the ONR monitor and assess any phenomena that might affect safety (for example something that may change the assumptions concerning external hazards) around each nuclear site. This is done as part of the normal regulatory process and during the PSRs required by LC15. In addition, the ONR maintains a database of the estimated population around nuclear installations, based upon the most recent 10-yearly population census, updated to take account of subsequent planning applications for residential developments.

Periodic Reviews of Authorisations and Environmental Permits

GH.52. Environmental permits or authorisations for the management of radioactive waste including discharges and solid waste disposals are reviewed regularly, including consideration of the level of actual discharges and disposals, the margin between discharges/disposals and limits, and the application of BAT under EPR16 or BPM under EASR18 and RSA93 to minimise waste generation and discharges/disposals to the environment. Against a background of UK government policy of progressive reduction in discharges overall, the environment agencies may decide to vary environmental permits, following a review, for example, to set revised limits or conditions or to require improvement programmes to be implemented.

International Obligations

GH.53. The UK has now left the EU and Euratom, however it is still a signatory to international conventions on early notification and has bilateral arrangements with near neighbours such as the Republic of Ireland and France. Under these arrangements and through information made publicly available on nuclear facilities and radioactive waste disposal facilities in the UK other CPs in the vicinity are kept apprised of any relevant developments.

Design and Construction of Facilities (Articles 7 and 14)

Articles 7 and 14 - Each Contracting Party shall take the appropriate steps to ensure that:

i. the design and construction of a spent fuel/radioactive waste management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;

ii. at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel or radioactive waste management facility are taken into account;

iii. at the design stage, technical provisions for the closure of a disposal facility are prepared;

iv. the technologies incorporated in the design and construction of a spent fuel management facility are supported by experience, testing or analysis.

GH.54. Under these Articles, compliance with the JC is demonstrated in a way that has not substantially changed since the sixth UK NR.

Design Measures to Protect People, Society & the Environment

GH.55. Any proposed new spent fuel or radioactive waste management facilities (except for some disposal facilities) will be built on either an existing or new licensed nuclear site. The well-established regulatory framework for nuclear installations applies to new facilities as outlined in Section E – Legislative and Regulatory System and in other sections of this report.

GH.56. New facilities are required to be designed and constructed to prevailing modern standards with safety features that provide defence-in depth to prevent abnormal occurrences or to mitigate their consequences, so that the chances of a release of radioactivity are minimised. Although the UK has a goal-setting regulatory regime it does take into account all relevant IAEA safety standards and other national and international standards; these are recognised as relevant good practice. There is a firm expectation that new facilities will be designed and constructed with these in mind.

GH.57. Central to demonstrating the safety of any nuclear facility in the UK is the requirement for the licensee to produce an adequate safety case. This sets out all aspects of the safety justification to show that risks from the facility have been reduced so far as is reasonably practicable.

GH.58. A fundamental element during facility design is the identification of all faults and hazards that could occur at a facility. This covers all significant sources of radioactivity, all planned modes of operation, and considers inter alia internal and external hazards, process faults, failures, and human error.

GH.59. ONR seeks the application, as appropriate and proportionate, of three broad types of fault analysis:

- Design basis analysis (DBA) should be used to provide a demonstration of fault tolerance at a facility by focussing on a simplified, conservative treatment applied the most significant faults (in terms of consequence and initiating fault frequency). An analysis of fault progression and consequences is used to determine the maximum effective dose to persons on or off the site. DBA is a key expectation and is the primary source of analysis supporting the design and operation of a facility including aspects such as: identifying limits and conditions; identifying operating rules; identifying and categorising safety functions; and classifying systems, structures and components. DBA, in particular, tends to focus on the preventing faults, and, when they do occur, protecting against further escalation.

- Probabilistic safety analysis (PSA) is a complementary but different methodology which undertakes a best-estimate analysis of a broader range of faults, including but not limited to those addressed in the DBA. The PSA should provide a more realistic and complete understanding of plant performance, with an understanding of areas of strength and of weakness in the fault resilience. It should allow the identification of key vulnerabilities, dominant fault sequences, an estimate of the absolute risks and of the relative distribution of those risks across the plant, range of faults and the groups at-risk of radiological exposure.

- Severe accident analysis (SAA) is a further technique used to consider those fault sequences that have the potential for very significant off-site consequences (>100 mSv to a member of the public). Rather than analysing the detailed progression of the early stages of fault sequences, SAA is usually focussed on understanding the key severe plant states that could arise. It uses best-estimate, or slightly conservative, analysis to assess how such plant states could progress to radiological release and aids in identification of measures to protect and mitigate such scenarios, with the goal of practically eliminating the occurrence of major radiological release.

GH.60. For significant new facilities ONR assesses safety cases using its SAPs and TAGs to judge their adequacy and in support of making decisions agreeing to activities such as commencing construction.

GH.61. New solid radioactive waste disposal facilities may be constructed on non-licensed sites and the environment agencies are the principal regulators in this case. They have published guidance documents on the requirements (in England and Wales) for authorisation of near-surface facilities [57] and of geological disposal facilities [108] for the disposal of radioactive wastes. The requirement for an environmental safety case relevant to safety in design is common to all guidance documents.

GH.62. The environmental safety case should include an environmental safety strategy supported by detailed arguments to demonstrate environmental safety. The environmental safety strategy should describe the fundamental approach taken to demonstrate the environmental safety of the disposal system. It should include a clear outline of the key environmental safety arguments and say how the major lines of reasoning and underpinning evidence support these arguments. The strategy should explain, for example, how the chosen site, design for passive safety and multiple barriers each contribute to environmental safety.

GH.63. The environment agencies' guidance sets out principles and requirements relevant to the design of solid waste disposal facilities. The principles are: -

- Principle 1: Level of protection against radiological hazards at the time of disposal and in the future;
- Principle 2: Optimisation (ALARA);
- Principle 3: Level of protection against non-radiological hazards at the time of disposal and in the future;
- Principle 4: Reliance on human action;
- Principle 5: Openness and inclusivity.

GH.64. Measures to limit the radiological impact of uncontrolled releases are described in Section 6.3 of each of the GRA documents [57] [108].

GH.65. Under the EASR18 and EPR16 regimes, the environment agencies apply a number of mechanisms to ensure the above, for example the requirements, including at the design stage, to use BAT or BPM to avoid or minimise waste arising and to dispose of waste in ways that minimise radiological impacts.

Pre-Application Assessment and Engagement

GH.66. As part of the conceptual planning for, and the early design stage of a nuclear or radioactive waste disposal facility the regulators carry out various forms of informal dialogue and pre-application engagement before site-specific applications are made and designs are finalised.

GH.67. An illustrative example of this early dialogue is the GDA process for potential new nuclear power station designs that may eventually be built in the UK. The GDA is a systematic process whereby ONR and the EA work jointly and meet with nuclear reactor vendors at an early stage, where they can have a positive influence on the safety and environmental impact of the design. This includes considerations of the facilities for radioactive waste management and spent fuel handling and storage on the site.

GH.68. In the GDA process the regulators undertake a technical assessment, using the SAPs, of the proposed design and associated safety features, and provide observations on any safety issues they may have identified for resolution. This approach assists developers in making better predictions on their costs and timescales. The process is open and transparent; the regulators make reports publicly available at the end of each step. This means that anyone can view potential safety issues and have the opportunity to comment on it via an open GDA comments process.

GH.69. A further example of early engagement is the pre-application assessment and scrutiny by the regulators of RWM, the developer of the GDF. ONR and EA routinely interact with RWM to provide advice on the expectations for an organisation that wants to develop its capability so that it will be able to apply for a nuclear site licence and environmental permit to construct and operate a GDF. The regulators periodically publish reports on their assessment of the progress being made by RWM and one was published in 2019 entitled 'Regulatory scrutiny and engagement for geological disposal: Annual report 2018/19' [114].

Decommissioning Provisions at the Design Stage

GH.70. There is a general expectation for new facilities that the ultimate decommissioning and dismantling is taken into account at the design stage. The design is expected to incorporate desirable features that would be expected to help reduce the complexity and difficulty and costs of decommissioning and waste management after the facility ceases operations. This includes consideration of design features, such as providing appropriate access for dismantling equipment that enable easier retrieval of wastes and other items and use of modular elements that can readily be removed, and of operational aspects of the facility that for example minimise the level of contamination in pipework and walls etc. and activation of components.

GH.71. The GDA process for assessment of the design of new nuclear power stations intended for construction in the UK requires that the requesting parties submit a strategy for decommissioning the plant at the end of its operational life. Regulators expect this strategy to identify what measures have been incorporated into the design of the reactor to facilitate its safe decommissioning and to ensure that the wastes generated during decommissioning are managed in accordance with the waste management hierarchy and can be managed safely until they are disposed of. This is assessed as part of the overall assessment of the adequacy of the design. This process allows regulators to leverage influence on the design of the reactor to ensure decommissioning is considered at the outset and wastes can be managed safely.

GH.72. The design and construction of new spent fuel and radioactive waste management facilities (other than disposal facilities) will consider aspects of their ultimate decommissioning and dismantling. The safety case will include an outline decommissioning plan to show how the design of the plant will facilitate its safe decommissioning and dismantling. LC 35 legally requires the licensees, from initial grant of the site licence, when no facility has yet been constructed to have decommissioning programmes for each facility that will operate on the licensed site. Conditions within permits granted by the environment agencies to nuclear site operators similarly require permit holders to establish a WMP and SWESC for each site so to help ensure provision is made for the optimisation of radioactive waste management arrangements and for sustainable site clean-up from the very start of activities [35].

Design provisions for the Closure of Waste Disposal Facilities

GH.73. In relation to the considerations, at the design and construction stage for the closure of a solid waste disposal facility, the environment agencies' guidance states that unreasonable reliance on human action to protect the public and the environment against radiological and non-radiological hazards is avoided both at the time of disposal and in the future (Principle 4 – Reliance on human action). There is also a requirement (R12) on the developer / operator of a disposal facility for solid radioactive waste to ensure that the site is used and the facility is designed, constructed, operated and capable of closure to avoid unacceptable effects on the performance of the disposal system. There is also a requirement (R14) to carry out a programme to monitor for changes caused by construction, operation and closure of the facility.

GH.74. The guidance also states that the environment agencies shall not consider the disposal process complete until all the requirements of the environmental safety case have been met. At the design stage and periodically during the lifetime of the facility, the developer / operator should demonstrate that it is able to close the disposal facility satisfactorily and, where relevant, seal any preferential pathways that will or may be introduced as a result of the siting, construction and operation of the facility.

Technologies Proven by Experience or Qualified by Testing or Analysis

GH.75. The design of new nuclear facilities benefits from the application of modern safety standards, such as those of the IAEA. In addition, operational experience feedback is available to allow enhancements to be made during the design and construction stages. It is sometimes a requirement of the safety case to include the qualification of equipment for design basis accidents. This qualification often involves arduous testing, or comprehensive analysis, or both, consistent with relevant standards and/or other specific regulatory requirements.

GH.76. For older plants, there will be no evidence from the design stage relating to requirements for equipment qualification and safety analysis. However, the experience of operation of earlier nuclear installations has provided operational, maintenance and inspection data. This has led to increased confidence in meeting required safety equipment performance levels or, alternatively, the need for a modification or replacement with more modern technologies meeting current safety design criteria, where appropriate.

GH.77. The environment agencies' guidance states that all work that supports the environmental safety case needs to follow good engineering practice. This usually means operators applying tried and tested methods, except where the technology used in the construction and operation of a disposal facility is at the leading edge of engineering practice. It also states that, in such instances, a judgment will need to be made as to whether the benefits of using a novel technology instead of an established method are sufficient to outweigh any uncertainties about the outcome of using it. Before the decision is made to use a novel technology, the environment agencies shall expect the developer / operator to have carried out trials to demonstrate that any such uncertainties are kept to a minimum.

Assessment of Safety of Facilities (Articles 8 and 15)

Articles 8 and 15: Each Contracting Party shall take the appropriate steps to ensure that:

i) Before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

ii) In addition, before construction of a disposal facility, a systematic safety assessment and an environmental assessment for the period following closure shall be carried out and the results evaluated against the criteria established by the regulatory body;

iii) Before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).

GH.78. Under these Articles, compliance with the JC is demonstrated in a way that has not substantially changed since the sixth UK NR.

Safety & Environmental Assessments

GH.79. As mentioned in the response to Articles 7 and 14 the licensees are required under general legal duties to perform risk assessments, and in particular under LC23 to systematically assess the safety of any proposed facility prior to its construction and this this is usually completed in the production of a Pre-Construction Safety Report (PCSR). This is one of a series of safety cases that will be developed through the construction and commissioning stages of a facility's lifecycle, taking into account any modifications to the design and the experience gained from commissioning activities. The Pre-Operational Safety Report (POSR) consolidates the safety case prior to the facility entering normal operations and will be used to derive the operating limits and conditions made in the interests of nuclear safety. The safety case consists of a tiered set of safety analysis reports covering a range of topics, from general safety principles through to detailed aspects of design and operation. This set of documents provides a written justification of the safety of the installation, for example: evidence to support the selection of the concepts and processes, detailed data used in calculations for specific components, calling as necessary on specific research and development programmes.

GH.80. There is also a requirement under LC15 to periodically review the safety case and update or amended it to take into account changing circumstances, which can include:

- developments in safety standards;
- transition from operations to decommissioning;
- interfaces with other plants;
- operational experience feedback; and
- plant modifications (including plant ageing effects) and emergent non-conformances.

GH.81. Supplementary documents may also be used to justify an activity at a particular time. For example, a method statement may demonstrate that the integrity of plant will be maintained and quality ensured during any modifications or during the installation of new plant. Similarly, any temporary plant modification may require a temporary change to the safety case to justify operations which lie outside the normal range of operations.

Environmental Assessments

GH.82. Any proposed new spent fuel or radioactive waste management (including disposal) facility will be subject to the extant environmental regulatory regime and the associated requirements to assess the environmental impacts of new projects. Where environmental assessment is required, the developer must prepare an environmental statement that includes a description of the likely significant effects on the environment and the measures envisaged to avoid, reduce or remedy any significant adverse effects.

GH.83. Any operator who wishes to apply for a permit from the environment agencies to manage, or dispose, solid, liquid or gaseous radioactive waste must provide a radiological impact assessment in support of their application. The assessment must take into account the likely routes of potential radiation exposure resulting from the disposals and the radiation doses received by the most exposed members of the public and to non-human species. The environment agencies' principles for the prospective assessment of public doses arising from permitted discharges are set out in reference [92].

GH.84. The environment agencies also take into account the radiological protection of the environment. The assessment tool ERICA [115] is available to support decisions about radiological protection of the environment.

GH.85. A permit application must also set out how the operator will minimise and monitor disposals and the presence of radionuclides in the environment that may result from the disposals in order to check that radiation exposures remain optimised and below statutory limits. The environment agencies will not issue any permit to dispose of radioactive wastes in any form (gaseous, liquid or solid) until they have assessed the application and supporting documentation, consulted upon it (including with members of the public) and published their conclusions.

GH.86. The environment agencies' guidance includes a number of requirements that are particularly relevant to these Articles for solid radioactive waste disposal facilities, including post-closure considerations.

Operation of Facilities (Articles 9 and 16)

Articles 9 and 16: Each Contracting Party shall take the appropriate steps to ensure that:

i) The licence to operate a spent fuel or radioactive waste management facility is based upon appropriate assessments as specified in Article [8] [15] and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;

ii) Operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article [8] [15], are defined and revised as necessary;

iii) Operation, maintenance, monitoring, inspection and testing of a spent fuel or radioactive waste management facility are conducted in accordance with established procedures;

iv) Engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel or radioactive waste management facility;

v) Procedures for characterization and segregation of radioactive waste are applied;

vi) Incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;

vii) Programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;

viii) Decommissioning plans for a spent fuel or radioactive waste management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body;

ix) Plans for the closure of a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility and are reviewed by the regulatory body.

GH.87. Under these Articles, compliance with the JC is demonstrated in a way that has not substantially changed since the sixth UK NR.

Licence to Operate a Spent Fuel or Waste Management Facility (i)

GH.88. As described in Section E – Legislative and Regulatory System of this report, new nuclear installations require a site licence from ONR and a permit from the relevant environment agency before constructing and operating a spent fuel or radioactive waste management facility. For new facilities on existing sites the LCs and permits apply requiring arrangements to be made to secure safe operations. The response to Articles 7, 8 14 and 15 provide further information on the safety assessment undertaken prior to and during the design and construction stages.

GH.89. Following the completion of construction of a spent fuel or radioactive waste management facility it is a requirement of LC21 that the facility is adequately commissioned. This is done typically in two defined stages i.e. the inactive and active stages. The commissioning arrangements are aimed at demonstrating, through testing and inspection that the facility meets both its design intent and the claims made in the safety case. Detailed records are made of the results of commissioning tests and inspections to allow for their assessment against defined criteria. The commissioning programme also takes into account modifications made during construction and during the commissioning stage to judge any implications for amending the safety case prior to the routine operational stage.

GH.90. ONR may specify a regulatory hold-point during any stage of the commissioning programme and the licensee requires ONR's Consent to proceed to the next stage. This use of regulatory powers is typically applied prior to radioactive material being introduced into the facility for the first time i.e. the active commissioning stage, and may also be notified prior to entry into normal operations. When ONR's Consent is required to commence full operation, the operators must submit a safety justification in the form of a safety case substantiated by the results of commissioning tests and inspections. In addition, ONR will inspect the readiness of the operator to move to the operational stage by examining relevant aspects of the management systems, such as operating and maintenance instructions and emergency arrangements.

GH.91. Prior to issuing a Consent ONR consults with the relevant environment agency to see that it is satisfied with the operator's ability to meet the requirements of the environmental permit.

Operational Limits and Conditions (OLC) (ii)

GH.92. The Operating Rules for a spent fuel or radioactive waste management facility are based on its safety case, as required by LC23. The Operating Rules comprise the set of OLC, including measurable plant parameters and other conditions that define the boundaries for safely operating the facility.

GH.93. From time to time operators may need to modify the plant or processes that affect OLC and any changes are managed through modification arrangements and classified by their significance to safety. ONR may specify that, once approved by ONR, no changes can be made to operating rules without ONR's prior approval, following consultation as appropriate with the environment agencies. Furthermore, the periodic safety review required under LC15 may lead to changes being made to OLC in the interests of safety.

GH.94. Environmental permits include a range of limits and conditions associated with the operation of a facility. In addition, the permits for radioactive waste disposal or discharge include a number of mechanisms to ensure that public dose and other statutory limits are met: through setting limits on discharges; requiring the use of BAT or BPM to avoid or minimise waste arising, and to dispose of unavoidable waste in ways that minimise radiological impacts; carrying out prospective assessment of doses from planned discharges.

GH.95. Operators must monitor the environment and assess doses actually received by those most highly exposed. An independent monitoring and assessment programme is also carried out by the environment agencies and the FSA.

GH.96. The environment agencies will periodically review environmental permits under EPR16 and EASR18 for the disposal of radioactive waste. Reviews may lead to revision of the limits and conditions in environmental permits.

GH.97. More detailed requirements are specified by the environment agencies in supporting documents to individual operator permits such as a Compilation of Environment Agency Requirements (CEAR) in England and Wales.

GH.98. One consequence of the requirement to use BAT or BPM to minimise disposals and the impact of disposals is that radiation doses to the most exposed individuals can be expected to be well below the statutory dose limit and dose constraints.

GH.99. The environment agencies will periodically review environmental permits under EPR16 and authorisations under EASR18 and RSA93 for the management of radioactive waste. Reviews may lead to revision of the limits and conditions in environmental permits and authorisations.

Operation, Maintenance, Monitoring, Inspection and Testing (iii)

Conditions of the site licence (LC24 & LC28) require facility operations, maintenance, monitoring, inspection and testing are all conducted in compliance with documented procedures that are periodically reviewed, kept up to date and authorised for use. Operators regularly and systematically carry out examination, inspection, maintenance and testing of all plant which may affect safety. This is normally controlled through the plant maintenance schedule, which specifies what maintenance is needed and on what frequency.

GH.100. Environmental permits include conditions requiring the operation and maintenance and testing of all equipment associated with the management of radioactive waste or discharge of radioactivity into the environment to be conducted in accordance with established procedures.

Engineering and Technical Support (iv)

GH.101. Nuclear site licences contain a number of requirements to ensure sufficient safety-related engineering and technical support is available throughout the lifecycle of a nuclear facility. In particular:

- only suitably qualified and experienced persons should perform any duties that may affect the safety of operations on the site; and
- requires the licensee to assess the safety impact of any change to its organisational structure or resources before these changes are carried out.

GH.102. Some of the larger nuclear operators, such as Sellafield, Magnox and EDF(NG), have their own technical support centres which provide technical support across their sites. Where an operator requires additional technical or engineering expertise, for example for maintenance of a facility during a shutdown, then it has access to the supply chain, original equipment manufacturers and other technical organisations. Some of this expertise may be from abroad. If a safety issue is identified by the operator it may require highly specialised support from academia including the need for investigation and research.

GH.103. Similarly, ONR has access to technical expertise through support contracts where advice can be sought from consultants and others into specific safety matters to assist ONR in making its regulatory decision.

GH.104. Licensees and other duty-holders, including the NDA, have research and development strategies to support their ongoing and future operations. This involves commissioning and undertaking research for a number of reasons including: the improvement or development of processes to aid the operations; work to support and justify safety positions and safety cases; innovation and potential novel approaches that may not come to fruition for a number of years; international collaboration on projects and the undertaking of work to ensure the necessary technical base of the industry is maintained within the academic network.

GH.105. TEA13 enables ONR to carry out or commission research in connection with its purposes and publish the results if it considers it appropriate to do so. It should be noted that ONR does not commission research either to support the commercial development of nuclear technologies or in areas for which other public bodies have regulatory responsibilities or are responsible for providing authoritative advice.

GH.106. ONR, in its current research strategy, has identified three main drivers for the commissioning of research:

- ONR requires independent advice to assist with our decision-making, particularly where the decisions we make might considered to be contentious.
- ONR has identified a knowledge gap which requires research and has invited the duty-holders concerned to complete the work and share their results. However, they have declined to do so, or declined to do so within acceptable timescales.
- ONR specialist require greater understanding and oversight of developing innovations or emerging subjects, to enable our regulatory decision to be based on the most up to date information.

GH.107. ONR's research lead meets with licensees and other duty-holders such as the NDA on a least an annual basis to discuss research strategy, share annual plans and progress, to maximise the value of research being undertaken. Additionally, ONR sits as an observer in the Nuclear Innovation and Research Advisory Board and also interacts with academic bodies and institutions such as the UK nuclear academics body and attends the annual nuclear academics discussion meeting.

GH.108. Internationally, ONR has membership of one of Autorité de Sûreté Nucléaire's (ASN, the French nuclear safety authority) Advisory committees and is also subject to number of MoUs with other regulators for Advanced Nuclear Technologies, which may have novel fuel cycles and waste treatment routes and shared research positions.

GH.109. The environment agencies may also commission their own research to support their regulatory assessments and decisions. For example, the Environment Agency contributed to the 5 year Radioactivity and the Environment (RATE) programme which ran between 2013 and 2018. This consisted of three projects being carried out by UK academic consortia with aims to:

- improve the scientific understanding of the behaviour and effects of radioactivity in the environment;
- increase the UK's environmental radiological research capability and capacity; and
- enhance environmental protection and safeguard human health from releases of radioactivity from nuclear power stations, waste repositories and legacy-contaminated sites, as well as natural radiation.

GH.110. The programme was jointly funded by Natural Environment Research Council (NERC), RWM and the EA.

GH.111. Similarly, in 2018 the Environment Agency commissioned research to support their newly published GRR guidance [35], reviewing the experience and lessons learnt from the re-use of existing below-ground structures, as well as different waste emplacement strategies, culminating in two Technical Reports shared with industry and available to inform the Environment Agency's regulation.

GH.112. The environment agencies require operators of both nuclear facilities and disposal sites to demonstrate compliance with their environmental permits or authorisations at all times. Operators must be able to demonstrate that they are meeting limits and conditions by having in place appropriate organisational management systems organisational structures and resources; this would include setting down and adhering to work procedures and having appropriate engineering and technical resources.

Procedures for Characterisation and Segregation of Waste (v)

GH.113. Waste characterisation forms an integrated part of an overall waste strategy in support of the management of waste throughout its lifecycle. Where appropriate waste segregation provides an efficient means of managing waste in relation to its hazard. It is the responsibility of radioactive waste producers (both nuclear and non-nuclear) both to characterise waste and to apply appropriate segregation to minimise the accumulation of radioactive waste on sites and to optimise its management (including disposal).

GH.114. Operators use a number of techniques in waste characterisation from historical records and radiological fingerprints to detailed characterisation plans, using data quality objectives or similar methods, and full radiochemical analysis. The sampling techniques cover radiological, physical and chemical properties, and are used to establish characterisation limits and boundaries for application. Operators also use a number of segregation methods, from mechanically vibrating screens, to remotely operated sorting with high resolution gamma spectrometry. As well as facilitating application of the waste management hierarchy, segregation of wastes is used by licensees in a number of ways, including: separation of short-lived wastes to enable decay storage; removal of items requiring special treatment; separation of waste materials that may react together as waste evolves over time. In the UK, waste management routes have been optimised for low level waste and include: metal recycling and re-use, volume reduction through high-force compaction and thermal treatment of combustible waste. For HAW, characterisation of waste ensures conformance with waste acceptance criteria for long-term storage and eventual disposal in a GDF or other facility.

GH.115. There are several radioactive waste disposal facilities in the UK permitted to disposal of lower activity radioactive wastes. This includes the LLWR. Each permitted site will only accept waste for disposal that meets its site-specific waste acceptance criteria, which have been derived from its site-specific environmental safety case.

GH.116. Characterisation, treatment, packaging and transport of radioactive waste for disposal are the responsibility of the consignor of the radioactive waste (e.g. nuclear site operator or other radioactive waste producer). However, it is the responsibility of the operator of the disposal facility (the consignee e.g. LLWR Ltd) to make sure that the waste accepted for disposal is consistent with the disposal facility environmental safety case and the operational requirements at the facility, including on-site transport and handling.

GH.117. At licensed nuclear sites LC32 requires minimisation of the rate of production and total quantity of radioactive waste accumulated on sites and LC33, requires that radioactive waste is disposed of in accordance with an environmental permit.

GH.118. MoU ensure that ONR and the environment agencies consult on radioactive waste management activities and means neither give permission / authorisation without taking full and meaningful account of the legal purposes of the other. Guidance to operators is available through ONR's guidance to inspectors and guidance published jointly between ONR and the environment agencies entitled 'The Management of higher activity radioactive waste on nuclear licensed sites' [6].

GH.119. The environment agencies' guidance sets out the requirement for waste acceptance criteria at radioactive waste disposal facilities (including the LLWR, landfills and incinerators). It states that the operator of a disposal facility for solid radioactive waste should establish waste acceptance criteria consistent with the assumptions made in the site-specific environmental safety case and with the requirements for transport and handling, and demonstrate that these can be applied during operations at the facility.

Reporting of Incidents to the Regulatory Bodies (vi)

GH.120. There are legal requirements for operators to notify and report incidents that occur on licensed nuclear sites, and during transport, to ONR and the environment agencies. The legal requirements are mainly included in the Nuclear Installations (Dangerous Occurrences) Regulations 1965, IRR17, LCs and sites' environmental permits or authorisations.

GH.121. ONR has published a Guide for operators entitled 'Notifying and Reporting Incidents and Events' [116] to use when deciding what to report. The guide includes incident reporting categories, the format and content of the notifications and the expected timescales for notification to ONR. These notifications require the inclusion of provisional International Nuclear and Radiological Event Scale (INES) ratings. The most significant incidents may be deemed by the operators to meet the criteria for reporting to government ministers, which they do as soon as practicable. On a quarterly basis ONR publishes an update in relation to incidents that have been reported to ministers by the operators on its website.

GH.122. Environmental permits require that the operator notifies the environment agencies promptly of incidents that have caused or may cause pollution or significant amounts of radioactive waste to be generated. Operators are also required to notify the environment agencies of breaches of permitted discharge limits and any significant adverse environmental effects resulting from operation of the facility.

GH.123. On behalf of the government, ONR is responsible for undertaking international reporting of incidents that have occurred in the UK. ONR fulfils the national officer and coordinator roles for the principal IAEA/NEA reporting systems, including: INES; the Fuel Incident Notification Analysis System (FINAS); and the International Reporting System for Operating Experience (IRS).

Collecting and Analysing Operating Experience (vii)

GH.124. Operators of nuclear facilities have well established arrangements to collect and analyse operating experience from: their own organisation; others in the UK; and from international sources. Predominantly this information is gathered from incidents reported, or information gathered, on their own sites. Operators take a graded approach to incident reporting through categorising them by their safety significance. On larger sites there may be thousands of reports made every year. Most of these are minor in nature and are often added to the database for trending purposes and not investigated further. Those of moderate safety significance are reviewed and the direct cause established, with corrective actions identified and taken to make improvements. For the most significant incidents a more comprehensive investigation is undertaken promptly, to identify the root-causes of the incident and to identify any necessary corrective actions to be taken in a timely manner to help prevent a recurrence.

GH.125. Other information such as the results of plant maintenance activities and routine examinations are collected by operators and used to analyse whether plant maintenance has been optimised. For example, plant operational history may be used to justify a change to the intervals between maintenance routines, or a change from preventive maintenance to condition-based monitoring maintenance to enhance safety systems' reliability.

GH.126. Where lessons are learnt from operational experience, such as those from investigating incidents, these may have implications for other operators and similar facilities. The UK operators have access to national and international databases and networks where they share relevant operating experience across the nuclear industry.

GH.127. Incident reports made by all UK operators to ONR are recorded on the ONR Incident Notifications database. As well as the details provided by the operators, the database is used to record ONRs initial response. The operators then subsequently provide ONR with a follow-up report containing information on the consequences, causes corrective action and lessons learned from the incident. ONR then has a complete picture of an incident's life-cycle. This information is analysed periodically to determine any generic issues or wider learning. The intelligence gained is used by ONR to review priorities and to target inspections of operators' activities.

Preparation of Decommissioning Plans (viii)

GH.128. The NDA is responsible for most of the decommissioning and clean-up of the UK's civil nuclear estate and it requires the sites' operators to have detailed decommissioning plans for all nuclear facilities. In addition, the ONR through LC35 requires the operators to have adequate arrangements for decommissioning nuclear facilities safely. This includes the production and implementation of decommissioning programmes and plans for each facility.

GH.129. Operators' decommissioning plans are drawn up taking into account government policy and, where appropriate, the NDA strategy. Different approaches are being adopted, some sites are being promptly decommissioned others are deferring final decommissioning to accrue the benefits from radioactive decay. Facility operators review and update decommissioning plans throughout the lifetime of the facility, mainly through periodic reviews and with increasing frequency as the facility approaches the end of its operational lifecycle stage. As a facility enters into its decommissioning stage there are a series of milestones agreed with ONR that represent significant hazard reduction activities being completed as the work progresses to an agreed end-state. The extent of regulatory oversight of the milestones and the plan are proportionate to the residual hazards being managed on the site.

GH.130. The environment agencies have published 'Guidance on Requirements for Release of nuclear sites from radioactive substances Regulation; (GRR) [35]. This guidance explains the requirements the environment agencies expect nuclear site operators to fulfil when developing their plans for the management of radioactive waste from decommissioning and how implementing these plans will leave sites in a state suitable for release from regulation (see Section E – Legislative and Regulatory System for more details).

Closure Plans for Radioactive Waste Disposal Facilities (ix)

GH.131. To date no UK radioactive waste disposal facilities have been finally closed. The environment agencies are the lead regulators for radioactive waste disposal. Their guidance states that the disposal process will not be regarded as complete until all the requirements of the environmental safety case have been met, which includes sealing and closure of the facility. The guidance states that, at the design stage and periodically during the lifetime of the facility, the operator should demonstrate that it is able to close the disposal facility satisfactorily and, where relevant, seal the access tunnels, shafts and drifts, boreholes and any other potential preferential pathways for radionuclide transport that will or may be introduced as a result of the construction and operation of the disposal facility. Through the design, construction, operation and closure stages the operator will need to take into account a number of effects that may arise from the properties of the waste, including:

- gas generation through microbial, chemical, or radiolytic action, or as a result of radioactive decay;
- heat generation through microbial or chemical action, or as a result of radioactive decay; and
- criticality through concentration of fissile nuclides.

GH.132. The UK is still seeking to identify a site for a GDF. Disposability of waste into the GDF and all aspects of its final closure is the responsibility of RWM. The safety cases required in support of licensing and permitting the construction and operation of a GDF are also required to address the plans for eventual final closure of the disposal facility.

GH.133. The environment agencies regulate any disposal, including discharge or off-site transfer of radioactive waste through permits and authorisations. MoU ensure that ONR and the environment agencies consult on radioactive waste management activities and means neither give permission / authorisation without taking full and meaningful account of the legal purposes of the other.

Disposal of Spent Fuel (Article 10)

Article 10: If, pursuant to its own legislative and regulatory framework, a Contracting Party has designated spent fuel for disposal, the disposal of such spent fuel shall be in accordance with the obligations of Chapter 3 relating to the disposal of radioactive waste.

GH.134. Compliance with this Article is demonstrated in a way that has not changed substantially since the sixth UK NR.

GH.135. Currently spent fuel is not designated as radioactive waste and is held in storage pending a future decision on its final disposition. If spent fuel is officially designated as radioactive waste, it will be disposed of in a GDF.

Institutional Measures after Closure of Radioactive Waste Disposal Facilities (Article 17)

Article 17: Each Contracting Party shall take the appropriate steps to ensure that after closure of a disposal facility:

i) records of the location, design and inventory of that facility required by the regulatory body are preserved;

ii) (ii) active or passive institutional controls such as monitoring or access restrictions are carried out, if required; and

iii) if, during any period of active institutional control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary.

GH.136. Under this Article, compliance with the JC is demonstrated in a way that has not substantially changed since the sixth UK NR.

GH.137. To date no radioactive waste disposal facilities have been permanently closed in the UK. However, the environment agencies' GRA for near surface and geological disposal facilities states that the developer/operator will need to set up and maintain a comprehensive system for recording information on all aspects of the project affecting the environmental safety case. The information to be recorded should include:

- decisions taken and the reasons for them;
- data and results from the site investigation and characterisation programme;
- design documents, drawings and engineering details of the facility as constructed;
- records of waste form and characterisation;
- records of waste emplacements and their location in the facility;
- details of facility closure; and
- results of monitoring and assessment at all stages of the project.

GH.138. Duplicates of the records should be kept at diverse locations and in durable form. During the period of authorisation, the records will be needed by both the organisation exercising control and by the regulators. The environment agencies also expect operators to make arrangements at the end of their period of authorisation, for the records to be included in the public archive.

GH.139. The guidance also states that the process of optimising a disposal facility requires the continuous attention of the developer / operator from the design stage through to the end of the period of authorisation. The requirement is for radiological risks to members of the public to be ALARA during both the period of authorisation and afterwards. Radiological risks during the period of authorisation are reduced by reducing exposure to radiation. Radiological risks after the period of authorisation are reduced either by reducing potential exposure, or by reducing the probability of that exposure being received.

GH.140. Disposal facility developers and operators are required to establish a strategy and programme for monitoring the facility to support the environmental safety case. This includes during any period of institutional control after closure of the facility. However, the environment agencies recognise that, in the longer term, institutional controls cannot be relied upon and the developer will be expected to assess the likelihood and consequences of possible future human actions.

Period of Institutional Control for Radioactive Waste Disposal Facilities

GH.141. If an environmental safety case claims a facility will be under active institutional control for some time after closure, the GRA requires the operator to provide evidence that the proposed arrangements will be reliably implemented. Any claims placed on active institutional control need to be supported by detailed forward planning and a demonstration of funding arrangements.

Such organisational arrangements may need to provide for:

- continued management and staffing;
- security;
- site surveillance, with scope for remedial work if needed;
- environmental monitoring;
- control of land use; and
- management of records.

GH.142. Operators are expected to provide evidence that these provisions can be relied on to remain effective throughout the claimed period of time. Because of the potential for major social changes, it is unlikely that the environment agencies would accept a claim for active institutional control lasting longer than 300 years after the end of waste emplacement.

GH.143. For any time after closure of the facility where the developer / operator does not claim, or the relevant environment agency does not accept, that there will be active institutional control, the regulatory approach will be to apply a risk guidance level (Requirement R6) and, for human intrusion to a near surface facility, a dose guidance level (Requirement R7). It is worth noting that there is no dose guidance level included in the Environment Agencies Guidance on authorising a GDF facility on the basis that human intrusion after the period of authorisation is unlikely to occur. Authorisations or permits for disposal will only be granted if it is shown that the continued isolation of the waste from the accessible environment shall not depend on actions by future generations to maintain the integrity of the disposal system.

Section I – Transboundary Movement

Article 27:

1. Each Contracting Party involved in transboundary movement shall take the appropriate steps to ensure that such movement is undertaken in a manner consistent with the provisions of this Convention and relevant binding international instruments.
   - (i) In so doing: a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement is authorized and takes place only with the prior notification and consent of the State of destination;
   - (ii) transboundary movement through States of transit shall be subject to those international obligations which are relevant to the particular modes of transport utilized;
   - (iii) a Contracting Party which is a State of destination shall consent to a transboundary movement only if it has the administrative and technical capacity, as well as the regulatory structure, needed to manage the spent fuel or the radioactive waste in a manner consistent with this Convention;
   - (iv) a Contracting Party which is a State of origin shall authorize a transboundary movement only if it can satisfy itself in accordance with the consent of the State of destination that the requirements of subparagraph (c) are met prior to transboundary movement;
   - (v) a Contracting Party which is a State of origin shall take the appropriate steps to permit re-entry into its territory, if a transboundary movement is not or cannot be completed in conformity with this Article, unless an alternative safe arrangement can be made.
2. A Contracting Party shall not licence the shipment of its spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.
3. Nothing in this Convention prejudices or affects:
   - (i) the exercise, by ships and aircraft of all States, of maritime, river and air navigation rights and freedoms, as provided for in international law;
   - (ii) rights of a Contracting Party to which radioactive waste is exported for processing to return, or provide for the return of, the radioactive waste and other products after treatment to the State of origin;
   - (iii) the right of a Contracting Party to export its spent fuel for reprocessing;
   - (iv) rights of a Contracting Party to which spent fuel is exported for reprocessing to return, or provide for the return of, radioactive waste and other products resulting from reprocessing operations to the State of origin.

I.1. The UK arrangements to comply with this Article have changed since the sixth NR as a result of the UK leaving the EU.

I.2. In this way the regulations laid down a set of procedures for the regulation and authorisation of shipments of radioactive waste and spent fuel within the Euratom community and a different set of procedures for shipments entering or exiting the community, i.e. movements to and from third countries. It also cross-referred in part to more detailed intra-community and extra-community procedural provisions contained within the Euratom Directive.

I.3. In this way the regulations laid down a set of procedures for the regulation and authorisation of shipments of radioactive waste and spent fuel within the Euratom community and a different set of procedures for shipments entering or exiting the community, i.e. movements to and from third countries. It also cross-referred in part to more detailed intra-community and extra-community procedural provisions contained within the 2006 Directive.

I.4. Following the UK's decision to withdraw from the EU and Euratom it was recognised that the procedures laid down to meet the 2008 regulations would become inoperable once the UK exited the EU, since they treat the Euratom area as a single bloc, including the UK. In order to ensure the UK is able to maintain a functioning regime in this area following EU exit, the UK will revoke the 2008 regulations and replace them with the Transfrontier Shipment of Radioactive Waste and Spent Fuel (EU Exit) Regulations 2019 [117]. These regulations will also revoke Commission Decision 2008/312/Euratom which established standard EU-wide documentation for the supervision and control of shipments of radioactive waste and spent fuel. The new regulations provide for procedures for the import, export, and transit of radioactive waste and spent fuel into and out of the UK and will apply from 1 January 2021. The procedural provisions that previously treated Euratom as a single bloc with mutual recognition of one another's authorisations are discontinued, since they do not apply to the UK now that it is a third country. Under the Northern Ireland Protocol, Northern Ireland is required to remain aligned with the Euratom Directive.

I.5. The EA is the Competent Authority (CA) for authorising shipments into and out of England; NRW, SEPA and NIEA are the CAs for their respective parts of the UK. The EA provides a service to NRW to allow businesses to ship spent fuel and radioactive waste materials both into and out of Wales. NRW remains accountable for all international shipments of radioactive waste and spent fuel.

I.6. Regulatory control of the import and export of radioactive wastes in accordance with the Transfrontier Shipment Regulations is achieved through the mechanisms of authorisation, consent and prohibition. The EA's International Waste Shipments team co-ordinates the sharing of authorisations between consignors and consignees, including confirmation of receipt of wastes. These arrangements allow for confirmation that wastes have been imported or exported in compliance with the authorisations and consents. Independent auditing of these arrangements by the EA (or the equivalent competent authorities in Wales, Scotland and Northern Ireland) ensures that they remain robust and effective and that, in the event of non-compliance, suitable provision for return or alternative arrangements can be secured.

I.7. On receipt of an application from the consignor of the waste or spent fuel, the relevant UK CA seeks the approval, in writing, from the CA of the country of destination (usually an environmental or nuclear regulator). It is UK practice to notify all countries of transit. In addition, before a shipment to or from the UK is authorised, the proposal will be checked for compliance with:

- The UK government policy on the import and export of radioactive waste; and,
- The UK government policy for the long-term management of solid low-level radioactive waste;

I.8. Trans-boundary movements of radioactive materials and spent fuel must comply with the national and international regulations and standards applying to the mode of transport used. For shipments by sea, safety of sea transport is governed by the Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997 [118].

I.9. There is a standing ban on shipments to destinations south of latitude 60 degrees south.

I.10. The export of radioactive waste for treatment is permitted provided it meets certain conditions, including a satisfactory options assessment and an assurance that the shipment is to facilitate the recovery of reusable materials or for treatment that will subsequently enable the waste to be more easily managed or stored when returned to the UK. In all cases where import or export of radioactive waste would add materially to the waste needing to be disposed of, the processed radioactive wastes have to be returned to the UK.

I.11. The reciprocal process applies when the relevant UK CA responds to a request to approve the import of radioactive waste into the UK.

I.12. EU Regulation (Euratom) 1334/2000 [119], Regulation 3(1) provides that "an authorisation shall be required for the export of the dual-use items listed in Annex 1". Nuclear materials are included in Annex 1. EU Regulation 1334/2000 is currently implemented in the UK by the Dual Use Items (Export Control) Regulations 2000 (SI 2000/2620) [120]. This usually results in an export licence application. In addition, the Nuclear Suppliers Group (NSG) Guidelines [121] are applied, as the UK is a member of the NSG and of the International Atomic Energy Authority (IAEA), and will continue to be after UK leaves Euratom.

I.13. Trans-boundary movement of radioactive substances between EU Member States was regulated by EU Regulation (Euratom) No 1493/93 [122]. This regulation only applies to 'shipments between Member States' and hence will not be relevant to the UK after the end of the transition period. From 1 January 2021, therefore, the obligation for source holders and consignees to obtain prior written declarations and submit quarterly returns falls away in practice as the retained law would not apply to shipments to / from the UK when it is no longer a Member State. In such a situation the UK environment agencies would no longer have access to the information currently gained through the prior written declarations on the destination of sealed sources being imported into the UK from the EU. These declarations help ensure the UK's high safety standards are maintained. Consequently the UK has revoked the EU Regulation (Euratom) No. 1493/93 and replaced it with The Shipments of Radioactive Substances (EU Exit) Regulations 2019 [117], which will come into force 1st January 2021.

I.14. These new regulations make provision to enable the system of prior written declarations to continue to function largely as before albeit with some changes that reflect the UK's new status as an independent sovereign state. This includes reflecting that the legislation will only apply for imports from the EU into the UK. In terms of exports from the UK into the EU, the issue of consent sits with the EU. It also replicates the previous requirement for a prior written declaration, but the obligation for Member State source holders to submit a quarterly return detailing all of the shipments (both sealed and unsealed) falls away. Not continuing this requirement does not reduce the UK environment agencies' oversight of the import of both sealed and unsealed sources. This information is already obtained in the UK through other legal requirements and environmental permit conditions.

I.15. The effect of the new Regulations is that before a shipment of sealed sources can take place from the EU into the UK, consignees will be required to make a prior written declaration demonstrating that they comply with national requirements for the safe storage, use and disposal. Declarations are sent by the consignee to the relevant environment agency in the UK, which will acknowledge receipt of the declaration. The consignee will then forward the declaration and acknowledgement to the source holder before a shipment of sealed sources can take place. These prior written declarations last for up to three years and may cover more than one shipment.

Transboundary Shipments in practice

I.16. The shipment of high-level vitrified waste by-products from reprocessing, from the UK to overseas clients, has been occurring routinely since 2010.

I.17. Since 2007, the UK has been exporting metallic wastes from nuclear decommissioning for treatment by melting. Shipments have been made to Sweden, Germany and the USA. The metal is mostly carbon steel, but alloy steels, depleted uranium and lead have also been treated and recycled. The overseas companies engaged in these recycling processes, with the exception of Bear Creek (USA), repatriate the radioactive furnace slag and other process wastes to the UK. As a large proportion of the metals are recycled, the secured reduction in the volume of radioactive waste metal requiring disposal in the UK's is typically greater than 10:1. This is an ongoing international trade.

I.18. Small numbers of shipments have been made for other treatments and processes, including incineration. The quantities of oil and other combustible wastes involved are generally low, as most combustible wastes are dealt with at UK facilities.

I.19. All shipments are carried out in compliance with the arrangements described above and hence with this Article.

Radioactive Items Detected at UK Borders

I.20. Cyclamen is the UK's Radiological and Nuclear detection capability at the border. Its purpose is to detect and intercept the covert importation of radioactive materials into the UK that are intended for criminal or terrorist activities. The capability uses a combination of fixed and mobile equipment to screen vehicles, containers, freight and pedestrians for the presence of nuclear and radiological materials at UK ports, airports and international rail terminals.

I.21. Whilst Cyclamen is principally aimed at matters of national security, the UK has experienced incidents at borders where radioactive material, including contaminated metallic consumer goods, has been discovered with no apparent malicious intent, and which the consignor was unaware of.

I.22. Wherever practicable, the UK has returned the discovered contaminated items to the consignor. In some cases, onward distribution in the UK has been allowed to proceed, where the measured radioactivity was below the exemption levels prescribed in UK environmental legislation. In cases where neither of these approaches was feasible, the UK authorities have faced the challenge of managing the contaminated items as radioactive waste, in order to secure their safe disposal in a manner that protects human health and the environment.

Section J – Disused Sealed Sources

Article 28:

1. Each Contracting Party shall, in the framework of its national law, take the appropriate steps to ensure that the possession, remanufacturing or disposal of disused sealed sources takes place in a safe manner.
2. A Contracting Party shall allow for re-entry into its territory of disused sealed sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.

J.1. Under this Article, the only significant changes to the UK's means of complying with the JC since the sixth UK NR are:

- the incorporation of the High Activity Sealed Radioactive Sources and Orphan Sources Regulations (HASS Regulations) into EASR18; and
- a surplus source disposal programme has been implemented to deal safely and effectively with orphan sources.

J.2. European Union Directive 2003/122/Euratom [123] on the control of HASS and orphan sources was originally transposed in the UK as the HASS Regulations, and as Directions from the Secretary of State and Ministers of the devolved administrations to the environment agencies. The subject of this directive was subsequently incorporated into the Basic Safety Standards Directive 2013/59/Euratom (BSSD 2013) [124], and thus included in the transposition of that Directive. Articles related to HASS were implemented in England and Wales through incorporation into EPR16 and in Scotland through incorporation into EASR18. In Northern Ireland, the provisions of the HASS Regulations continue to apply. These legal provisions provide the UK regulatory regime for management of high-activity sealed sources.

J.3. EPR16 in England and Wales, EASR18 in Scotland and the relevant domestic legislation in Northern Ireland lay out a regulatory system for the authorisation of practices involving high-activity sealed sources. Under these regulations, before issuing such an authorisation, the relevant CA must ensure that adequate arrangements exist for the safe management of sources, including when they become disused sources. These arrangements may provide for the transfer of disused sources to the supplier or to a recognised storage facility.

J.4. At the time of writing there were 286 HASS permit and registrations in the UK.

J.5. Financial provision must be made to cover the cost of managing disused sources safely in the eventuality of the holder becoming insolvent or going out of business. The UK government has developed guidance for the EA [125] (also applicable to NRW) on the acceptable arrangements companies can make to meet the requirements for such financial provision.

J.6. There is a requirement for nuclear site operators and other holders of HASS to keep records of all HASS in their possession and to report specified information when a HASS is acquired, transferred or decays below the HASS threshold to ONR or the relevant environment agency, respectively. Holders of HASS are also required to provide these records to ONR or the relevant environment agency at periodic intervals. These HASS records are held in a national HASS database, which provides a comprehensive record of all HASS in the UK.

J.7. On licensed nuclear sites, licence conditions require operators to control the entry and storage of nuclear matter (including sources) on the licensed site. In all cases, IRR17 applies, covering the arrangements for the control of radioactive substances, Articles and equipment. The ONR requires the relevant licensees to provide information to the ONR to demonstrate compliance with legislation covering HASS.

J.8. The Transfrontier Shipment of Radioactive Waste and Spent Fuel Regulations 2008 (see Section I – Transboundary Movement), Regulation 3(2)(a), excludes "a shipment of disused sources to a supplier or manufacturer of radioactive sources or to a recognised installation". Therefore, the transfrontier shipment of such sources does not require prior authorisation. Shipments of sealed sources between Member States of the EU are regulated under the European Commission (EC) Regulation 1493/93 which the UK will revoke, replacing it with The Shipments of Radioactive Substances (EU Exit) Regulations 2019 [117]. The new regulations will apply from 1 January 2021.

J.9. The environment agencies implement a number of measures designed to ensure the identification and safe management of disused orphan sources and other forms of radioactive waste that may occasionally be found among scrap metal. As part of the implementation of the Industrial Emissions Directive [126], permits issued to metal shredding facilities in England now include a condition requiring that all metal waste delivered to site is monitored for radioactive substances. The EA has introduced a standard rules permit for unintentional receipt of radioactive materials [127], superseding a RPS [128], for scrap metal sites in England that requires that any discovered radioactive material or radioactive waste is stored safely and securely while it is assessed and an appropriate course of action is determined. This aims to ensure that radioactive waste in scrap metal is promptly brought under a system of control, whilst preventing the stockpiling of radioactive waste at scrap metal sites. In Scotland, such sites need to notify SEPA if they find an orphan source or radioactive scrap metal. As part of the transposition of BSSD13, EASR18 introduced conditions for the larger scrap metal sites requiring them to establish systems to detection radioactive contamination, inform SEPA promptly if they have, or suspect radioactive contamination in material and to only dispose of such materials with SEPA's approval.

J.10. The environment agencies have also provided guidance [129] for businesses and other organisations that have kept and used sealed sources and mobile radioactive apparatus, under the conditions of a permit or an exemption, and where those sources have now become waste.

Surplus Source Disposal Programme and Recognised Installations

J.11. The environment agencies and the UK government have engaged with the NDA to ensure that adequate arrangements for the safe management of orphan radioactive sources are in place. This includes a long-term commercial arrangement to provide appropriate licensed transport containers and long-term storage facilities for disused sealed sources at Sellafield from where they can be disposed of to a GDF (when available) without further handling / processing. An established framework is in place for the safe recovery of any orphan source discovered in a public place: the National Arrangements for Incidents involving Radioactivity (NAIR) scheme, which involves the police and nuclear sites' operators or major hospitals recovering an orphan source. A similar scheme is in place in Northern Ireland.

Section K – Update on progress on issues raised at the Sixth Joint Convention Review Meeting

This section provides an opportunity to give a summary of safety issues of concern identified earlier, and planned future actions to address those issues, including where appropriate, measures of international co-operation.

K.1. This section is used to provide a summary of progress made with the issues and challenges that were identified at the sixth JC RM, referring out to earlier sections of this report where more detail is provided on actions being taken or planned. In addition, it provides information on the full scope IAEA IRRS peer-review mission that was undertaken to the UK in October 2019.

Progress in relation to the overarching issues and challenges identified at the sixth review meeting

K.2. The President's and JC final summary reports from the sixth RM reported on overarching issues which were identified from the country group discussions and that pose challenges for multiple contracting parties that may benefit from increased attention at future RMs. It was agreed by the JC that four of these should be addressed in the NRs presented to the seventh RM. In addition, the Country Group 4 Rapporteur's report highlighted particular challenges for the UK to address and report on progress in the seventh UK NR. There were no suggestions made.

K.3. The issues and challenges from the sixth RM are summarised in Table 5 below, with cross references to sections in this report where more detailed information is provided.

Table 5: Summary of overarching issues and challenges highlighted in the sixth JC RM

Description	Summary of UK Response	Section in 7th UK NR
Overarching Issues		
Implementation of national strategies for spent fuel and radioactive waste management.	UK has a well-established and mature policy and strategy framework, which is implemented effectively across the nuclear industry.	Sections B and GH
Safety implications of the long-term management of spent fuel.	Spent fuel (apart from that from the PWR at Sizewell B) has historically been reprocessed. Following cessation of reprocessing activities in 2020/21, spent fuel will be put into interim storage, pending a future decision on its disposition. Fully developed plans and underpinning safety justifications for safe interim storage of AGR fuels (and some other NDA-owned oxide fuels) in the THORP Receipt and Storage Pond are in place.	Section B (notably paras B13-16 and B19-24)
Linking long-term management and disposal of disused sealed radioactive sources.	The UK has established and implemented arrangements to ensure that the NDA provides access to a Recognised Installation for the long-term management of disused sealed radioactive	Section J (notably J11)

Description	Summary of UK Response	Section in 7th UK NR
	sources, pending their disposal in a GDF.	
Remediation of legacy sites and facilities. (This issue was also identified as a UK challenge)	The remediation of high-hazard facilities at Sellafield remains the UK's highest decommissioning priority. Wastes are being removed from legacy cooling ponds and substantial progress has been made in preparations for retrieving wastes from legacy silos at Sellafield. Decommissioning of other sites, including the 12 Magnox Ltd sites and Dounreay continues, with some key milestones being reached.	Sections B (notably paras B181-272) GH L.2 (Table 13, Table 14)
UK Challenges		
Implications of the UK withdrawal from the Euratom treaty.	The UK left the EU and the Euratom treaty on 31 January 2020. The UK is now within a transition period which is (at the time of writing) planned to end on 31 December 2020. This will not result in any substantive changes in the UK's management of spent fuel and radioactive waste management or in relation to complying with the JC. All necessary measures have been put in place to ensure that the civil nuclear sector can continue to operate at the end of the transition period. This includes the establishment of a UK State System of Accountancy and Control of Nuclear Materials.	Sections A E (notably paras E7-8) I (notably paras I4-15) J (notably paras J8)
Decommissioning the fleet of shutdown Magnox NPPs.	Bradwell became the first UK nuclear power station to enter into an extended 70 year period of Care and Maintenance. Decommissioning at all other Magnox reactor and research sites continues to make good progress.	Sections B, (notably paras B236-267) L.2 (paras L.2.45-L.2.52, Table 14)
Identifying a suitable site for deep geological waste disposal.	The process to identify a suitable site for a GDF in England and Wales is underway. UK and Welsh Governments have published a consent-based policy for geological disposal. A National Policy Statement describing the process for planning decisions for geological disposal infrastructure in England has also been published. RWM has undertaken a geological screening exercise covering England, Wales and Northern Ireland (noting that there are no plans to site a GDF in Northern Ireland).	Sections A B (notably paras B60-77) GH (notably paras GH30-53)
Maintenance of UK's spent fuel and radioactive waste infrastructure.	UK is maintaining and developing its infrastructure as reprocessing spent fuel nears an end. Operators must maintain their facilities in a safe condition as a requirement of their site licences and environmental permits (at non-nuclear sites). ONR and / or the relevant environment agency carry out site inspections and assessments to ensure compliance with legal requirements.	Sections B (notably paras B13-16, B19-24, B27-29) E (notably paras E31-45)
Sustaining UK's nuclear skills base (particularly for decommissioning).	UK is proactively addressing the skills challenges facing the UK nuclear industry. The NSSG has active training programmes,	Section F (notably paras F13-25)

Description	Summary of UK Response	Section in 7th UK NR
	activities and initiatives, to maintain and expand the UK's nuclear skills base to support the industry's needs and future ambitions.	

Planned activities to address on-going challenges and improve safety

K.4. The UK recognises the importance of securing and sustaining public confidence in the safe management of the UK's nuclear and radioactive waste management facilities. There is a significant decommissioning legacy and a growing accumulation of radioactive waste and other radioactive material, such as LLW, HAW, spent fuel and special nuclear material. These liabilities are predominantly publicly owned and the majority are or will end up being stored on the NDA owned sites. For LLW, which constitutes the vast majority of radioactive waste by volume, the UK has well-established treatment and disposal routes available. HAW is being stored safely above ground, pending its future management in line with national policies (geological disposal in England or Wales and management in near surface facilities in Scotland). The inventory will be stored until a GDF becomes available or other disposal solutions are identified. The public demands high levels of nuclear and radiation safety and the operators of nuclear and radioactive waste facilities and other users of ionising radiation work within a well-established legal framework which reflects relevant international standards.

K.5. The operators of nuclear and other radioactive waste facilities have implemented arrangements for complying with all relevant legislation. They are adequately resourced to underpin safe operations, understand the hazards and risks they are dealing with, and are committed to the adoption of relevant good practice through continuously seeking and making reasonably practicable improvements to safety. There are well established processes for sharing learning and for operators to report incidents on site to the regulators, to enable good practice and relevant experience to be promulgated more widely.

K.6. The regulators maintain regulatory oversight of nuclear operations through carrying out programmes of planned inspections and other regulatory activity to ensure on-going compliance with legal and regulatory requirements.

K.7. As mentioned in several places in this report, one of the most significant challenges continues to be remediation of the high-hazard legacy ponds and silos at the Sellafield site. Substantial progress has been made since the sixth UK NR to address this challenge. Waste is being retrieved from legacy ponds and the retrievals capability for the silos is being deployed and is approaching active commissioning. This work is exemplifying the use of the 'decommissioning mind-set' to drive forward timely and effective decommissioning in these legacy facilities, facilitating the use of innovative approaches and avoiding blockers and distractions which could impede progress.

K.8. The decommissioning of Magnox nuclear power stations and other legacy nuclear facilities is progressing steadily, with well-defined and funded decommissioning plans in place. The inventory of HAW is being managed appropriately in safe interim storage; confidence on its final disposal is provided through the mature RWM LoC process and use of the RWM gDSSC.

Full scope IAEA IRRS peer review mission to the UK in 2019

K.9. There have been four IAEA IRRS missions to the UK since the first programme began in 2006. The first three were reduced scope missions, focussed on specific areas of nuclear regulation, for example the first mission in 2006 focussed on the UK's preparations for regulation of the design and construction of new nuclear power stations. Subsequent missions were conducted in 2009 and 2013 to review new areas, with an expert follow-up mission in 2014 to review progress made in addressing the open findings from previous IRRS missions.

K.10. The first full-scope IRRS mission to the UK took place in October 2019. This covered the UK's full radiological safety framework and involved 12 government departments and 16 regulatory bodies, including ONR and the environment agencies. On behalf of the government, ONR coordinated and hosted the IRRS mission team of 18 reviewers, 3 observers and 3 IAEA staff in its offices in Liverpool.

K.11. The IAEA team provided recommendations and suggestions across 10 of the IRRS Modules. Table 6 below highlights 21 of the 45 findings identified during the review that are considered to be more specifically related to the scope of application to the JC.

Table 6: Findings from the 2019 IRRS Mission to the UK relevant to the Joint Convention

Module Area of Review	Finding of the IRRS Mission: Recommendation (R)/Suggestion (S)
M1 Responsibilities and functions of the government	S1: The UK government should consider improving the coordination among the regulatory bodies and with government departments to ensure effective delivery of their regulatory functions including by addressing gaps in existing coordination arrangements.
M1 Responsibilities and functions of the government	R2: The UK government should revise: • the Nuclear Installation Regulations 1971 such that GDF is defined as a nuclear licensed site and is subject to ONR authorization; and • the Nuclear Installation Act 1965 to include requirements on release of nuclear licensed sites from regulatory control with restrictions on the future use.
M2. Global Safety Regime	R3: The UK government, in consultation with regulatory bodies should formalise and improve existing processes and arrangements for sharing of operating and regulatory experience to ensure systematic analysis and feedback on measures taken in response to information received.
M2. Global Safety Regime	S2: The UK government should consider notifying the IAEA of its commitment to the Supplementary Guidance on the Management of Disused Radioactive Sources.
M3. Responsibilities and Functions of the RB	R5: SEPA should continue to develop and implement a competence framework and develop a human resources and training plan in its department of radioactive substances, including related procedures.
M3. Responsibilities and Functions of the RB	R8: ONR should establish provisions for interested parties and the public to be appropriately consulted in its process for making significant regulatory decisions, establishing regulatory guidance or when updating licence conditions.
M4. Management System of the RBs	R9/10: ONR and EA should further develop and implement their Integrated Management System to fully comply with the IAEA safety standards.
M6. Review and Assessment	S10: The ONR should consider revising the relevant decommissioning guidance to provide clarity on how it undertakes periodic regulatory review of decommissioning plans.

Module Area of Review	Finding of the IRRS Mission: Recommendation (R)/Suggestion (S)
M7. Inspection	S13: ONR should develop clear expectations and associated guidance for inspection staff in how much time should be dedicated to general surveillance of facilities and how it should be accomplished independent of scheduled inspection activities.
M7. Inspection	R12: EA should provide guidance on how to apply a graded approach in determining the appropriate frequency of inspections for the areas and programs inspected for nuclear facilities.
M7. Inspection	R14: HSE, HSENI, and ONR should review their individual occupational exposure inspection guidance to ensure they adequately address the relevant safety aspects to be included in the scope of inspections.
M9. Regulations and Guides	R16: The EA, NRW, SEPA, NIEA should further develop processes and procedures for the establishment, review and update of regulatory guidance to include applicable IAEA safety standards.
M9. Regulations and Guides	R17: The environment agencies should make more direct reference to the requirements for isolation and containment of radioactive waste and should clearly indicate in their guidelines that no radioactive discharges are expected from disposal facilities.
M9. Regulations and Guides	R18: The environment agencies should further develop their guide NSD-GRA to clarify the role of and its expectations for passive safety in providing additional assurance of the safety of a disposal facility.
M9. Regulations and Guides	R19: The EA should review its approach to clearance, to consider the use of case and site-specific activity concentrations in helping enable the minimisation of radioactive waste production.
M9. Regulations and Guides	R21: Once relevant legislative changes have been implemented, the ONR should review and update the decommissioning guidance to reflect the requirements on release of the nuclear site from their regulatory control with restrictions on the future use.
M10. Emergency Preparedness & Response Regulatory Aspects	R23: The government should review the UK EP&R framework to explain how the requirements of GSR Part 7 are met in terms of EALs and OILs, and if any gap exists develop appropriate regulatory requirements.
M10. Emergency Preparedness & Response Regulatory Aspects	R24: The government should review the UK EP&R framework to explain how the requirements of GSR Part 7 are met in terms of planning zones and distances, and if any gap exists develop appropriate regulatory requirements.
M10. Emergency Preparedness & Response Regulatory Aspects	S18: ONR should consider establishing pre-defined communication with the operating organizations in terms of plant data and other information during emergencies.
M10. Emergency	S19: The ONR should consider integrating its response arrangements into a

Module Area of Review	Finding of the IRRS Mission: Recommendation (R)/Suggestion (S)
Preparedness & Response Regulatory Aspects	response and preparedness plan and formalize training and qualification of emergency response staff.

K.12. The UK is committed to addressing the recommendations and suggestions made by the IRRS mission; this will be facilitated by the UK Radiological Safety Group (RSG). This group has been tasked by government to provide strategic oversight of the UK's regulatory framework for radiological safety with a key objective of ensuring strategic alignment, co-ordination and shared learning and information across the UK to help maintain an effective regulatory framework. Membership of the RSG is set at Senior (Director) level from each of the departments and regulatory bodies with a responsibility for nuclear and radiological safety to ensure appropriate strategic perspective, accountabilities and authority.

K.13. A Radiological Safety Working Group (RSWG) has been established which sits beneath the RSG. It comprises officials (including technical experts) from departments and regulatory bodies and is responsible for developing a forward look of key international radiological safety standards/requirements for the RSG to consider. Importantly, RSG is also tasked with tracking the progress on closing IRRS findings in addition to highlighting opportunities arising from international standards and relevant good practice.

K.14. All recommendations and suggestions have been assigned to the relevant organisation and progress on the close out of the recommendations and suggestions is reported on a regular basis. Priority has been given to work to close out recommendations in the first instance.

K.15. The IAEA's report on the full scope 2019 IRRS mission to the UK [130] and the UK Government response to the report [131] are available online.

International Collaboration

K.16. The UK recognises that nuclear safety is of global concern and that each country benefits from the high standards of nuclear safety upheld in other countries. The UK is therefore committed to optimising collaboration and cooperation to promote high levels of nuclear safety world-wide. As part of this, the UK is an active participant in a number of multilateral fora, including those of the IAEA and the NEA. Although the UK left the EU in 2020 it remains a member of some European groups such as the Western European Nuclear Regulators Association (WENRA) and the Heads of European Radiation protection Competent Authorities (HERCA). The UK contributes by providing experts to assist the work on updating international safety standards safety reference levels and guidance etc. UK is also a Contracting Party to the Convention on Nuclear Safety (CNS) and has bilateral agreements in place with other countries. The UK uses the information and intelligence gained from this international involvement to benchmark its own safety standards and associated arrangements.

K.17. The main international groups relevant to radioactive waste and spent fuel management in which the UK is actively involved in includes:

- IAEA Activities
    - Waste Safety Standards Committee (WASSC);
    - IRRS and ARTEMIS missions;
    - International Project on Completion of Decommissioning (COMDEC);

- WENRA, in particular its Working Group on Waste and Decommissioning (WENRA WGWD); and
- NEA
  - Committee on Decommissioning of Nuclear Installations and Legacy Management (CDLM);
  - Radioactive Waste Management Committee.
- International Nuclear Regulators' Association (INRA)

K.18. Nuclear Cooperation Agreements (NCAs) are legally binding agreements negotiated between two States (or in the case of Euratom, a Community of states) setting out a high-level framework for cooperation on civil nuclear matters, especially the safeguarding of sensitive material, and facilitating nuclear trade. Some countries require an NCA to be in place before such trade with other countries can be permitted – for example: Australia, Canada, Japan and USA. NCAs represent the development of a long-term and constructive relationship between two parties.

K.19. Whilst a member of the EU and Euratom, NCAs agreed between Euratom on behalf of the community and third countries, including the four above, applied to the UK. At the end of the transition period, these agreements will no longer apply to the UK. Therefore, the UK has negotiated and ratified its own NCAs with Australia, Canada and the USA. In addition, Japan and the UK have formally exchanged letters to confirm the ongoing application of the existing NCA between the two countries. To strengthen this exchange, the UK is currently in the process of agreeing the text of an amending protocol with Japan, but this does not have to be completed by the end of the transition period.

K.20. The UK and EU have agreed upon the Political Declaration which clearly commits both parties to a separate and wide-ranging NCA between Euratom and the UK. The UK is currently negotiating with the European Commission for a future relationship based on such a NCA.

K.21. Similarly, ONR enters into Information Exchange Arrangements (IEAs) [132] with other international nuclear regulators in order to share information, experience and good practice where it is believed to be mutually beneficial and in the UK's national interests. Each IEA is different, but in general covers the exchange of safety-related information concerning the regulation of the civil nuclear industry, including in relation to the safe management of spent fuel and radioactive waste and decommissioning facilities, and preparedness for and management of nuclear and radiological emergencies.

K.22. The NCAs and IEAs have provided significant mutual benefit to the UK and the other countries in terms of sharing knowledge and experience. This is illustrated with experience from representative experience with some key nuclear partners:

- An IEA has been in place with ASN of France since 2018. This has involved exchange of knowledge and expertise in areas such as:
  - POCO and management in legacy facilities;
  - Spent fuel reprocessing, learning from experience at La Hague;
  - New reactor design as part of the UK GDA work.

  There have also been a number of secondments of staff between ONR and ASN, enabling a close sharing of each organisations approach to regulation.
- An IEA has been in place with the nuclear regulation authority of Japan since 2018. This has involved exchange of knowledge and expertise in areas such as:
  - Post-accident legacy management. Including participation in the Fukushima international forum in August 2019;
  - Engaging with the public;
  - Sharing decommissioning expertise.

K.23. Other examples of international collaboration include:

- There has been considerable international engagement on geological disposal by both RWM and UK regulators. ONR and EA have engaged closely with regulatory bodies in the USA, Sweden and Finland, including information gathering visits to existing operational disposal facilities, to share technical knowledge and gain valuable insights on the regulation of these facilities and operational experience that can be used to inform the UK approach.

  RWM, in its role as developer for a proposed UK GDF, is active in relevant international groups, including the International Association for Environmentally Safe Disposal of Radioactive Material (EDRAM), the Executive Group of the European Implementing Geological Disposal of Radioactive Waste Technology Platform (IGD-TP) and the European Joint Programme on Radioactive Waste Management (EURAD). Interactions such as these help ensure that RWM makes best use of international knowledge and experience on geological disposal;

- NDA, Dounreay and technical partners are engaged with the Japanese Atomic Energy Authority (JAEA) authorities to share expertise gained through the decommissioning of the Dounreay PFR to support decommissioning of the Monju reactor [133].

- The UK's NNL recently signed a Practical Arrangement, with IAEA aimed at enhancing cooperation in a range of areas including decommissioning, radioactive waste management and disposal.

Section L - Annexes

Section L.1 – Legislative and Regulatory System

L.1.1. This section includes additional details related to Section B - Policies and Practices, Section E – Legislative and Regulatory System, and Section F - Other General Safety Provisions. It provides a fuller description of the United Kingdom's (UK's) legislative and regulatory framework, of the regulatory bodies, and of the other national organisations involved in spent fuel and radioactive waste management. Section L.1 provides a comprehensive listing of UK legislation relevant to the JC.

UK government and devolved administrations

L.1.2. The UK government's nuclear industrial strategy [134], part of the wider Industrial strategy [41], sets out the strategy for the future of the civil nuclear sector. This is routinely delivered in consultation with the other relevant devolved administrations. It covers: Waste management and decommissioning, operations and maintenance and opportunities in the nuclear new build programme. In support of this it includes commitments to R&D and innovation and plans to ensure an adequate nuclear skills base.

L.1.3. The UK government retains responsibility for nuclear safety, energy and security. The devolved administrations of Scotland, Wales and Northern Ireland have their own policies, where relevant, in relation to the nuclear sector and nuclear energy and retain responsibilities for radioactive waste management and environmental protection. There are no nuclear facilities in Northern Ireland.

L.1.4. The Department for Business, Energy & Industrial Strategy (BEIS) is the government department responsible for establishing government policy in relation to the use of nuclear power. It also has responsibility for the regulatory framework in place to ensure that high standards of nuclear safety are observed in the UK, and that any international obligations related to nuclear safety are met. ONR advises BEIS on nuclear safety and security matters. ONR is sponsored by Department for Work and Pensions (DWP), to ensure it is independent from BEIS and the setting of nuclear policies.

L.1.5. The NDA is a non-departmental public body, which owns and is responsible for decommissioning and cleaning up 17 publicly owned civil legacy nuclear sites across the UK, including Sellafield and Magnox sites. It is also responsible for implementing government policies on the management of nuclear wastes. The NDA is accountable to both the UK government and Scottish Ministers. It is not a regulatory body and does not have vires to enforce any legal requirements.

L.1.6. The UK government and devolved administrations sponsor the relevant regulatory bodies, ONR and environment agencies (Figure 39).

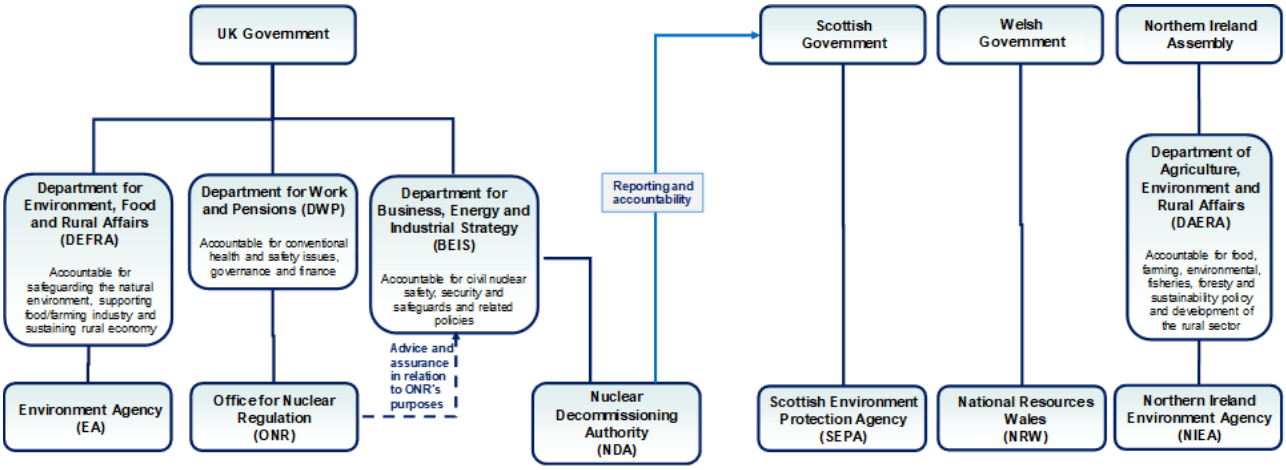


Figure 77: UK government and devolved administration's sponsorship of regulatory bodies

Regulatory bodies

L.1.7. The main UK regulatory bodies in relation to the safe management of spent fuel and radioactive waste are listed below. The descriptions provide a general overview of each body in relation to its structure, function and funding.

The Office for Nuclear Regulation (ONR)

Mandate and Duties

L.1.8. The Office for Nuclear Regulation (ONR) is responsible for regulation of nuclear safety, security and safeguards across Great Britain (GB). It independently regulates nuclear safety, security and safeguards at all licensed nuclear sites in the GB and transport of radioactive materials by road and rail. ONR's mission is to protect society by securing safe nuclear operations, with a vision to be a modern, transparent regulator delivering trusted outcomes and value.

L.1.9. ONR was established in 2013 by TEA13. Prior to this ONR had been part of the HSE and before 2011 was called the Nuclear Installations Inspectorate (NII).

L.1.10. TEA13 defines ONR's purposes and functions on licensed nuclear sites:

- Protect persons against risks of harm from ionising radiations from GB nuclear sites;
- Securing the health, safety and welfare of persons at work on GB nuclear sites;
- Ensure the security of civil nuclear premises and nuclear material; and
- Ensure compliance with safeguards obligations; and
- Protect against risks relating to the civil transport of radioactive material in GB and ensure its security.

L.1.11. ONR operates the nuclear site licensing regime, defined in NIA65 and is the authority that grants, enforces, varies and revokes nuclear sites licences and attaches conditions to them in the interests of safety.

Organisational Structure

L.1.12. ONR is organised within a number of Directorates; the Regulatory Directorate provides the core regulatory functions and is supported by corporate functions, such as finance and human resources. For further detail see the Organogram below in Figure 40.

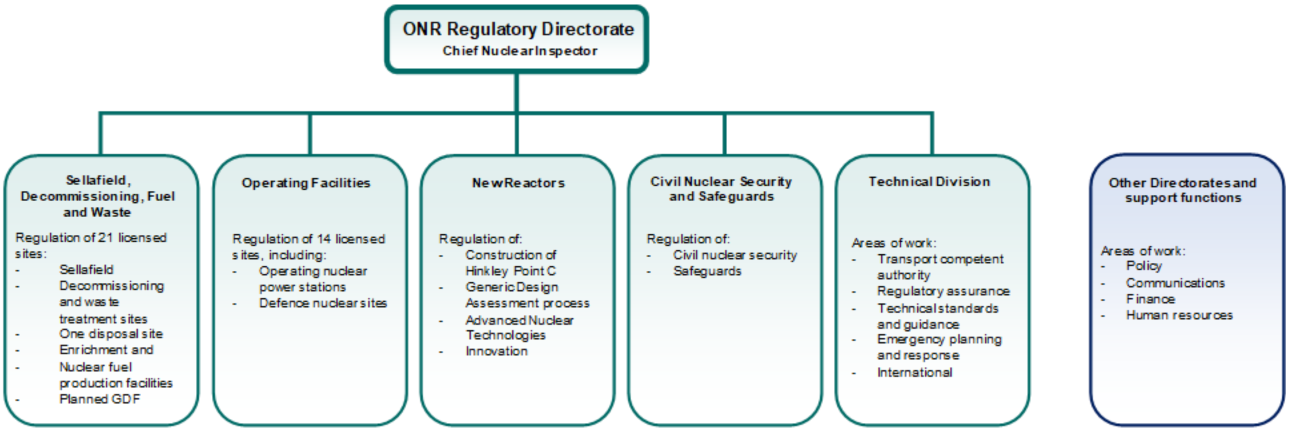


Figure 79: ONR organisational structure

Financial Resources

L.1.13. ONR is legally empowered to recover from industry and government departments the cost of providing its services. These charging powers come from a number of pieces of legislation, including NIA65, which enables financial charges to be imposed on nuclear licensees to recover expenses incurred through ONR's regulation of nuclear installations.

L.1.14. ONR recovers most (around 95%) of its running costs from the nuclear industry it regulates and government departments to which it provides a service; with the remainder provided by the sponsor department, DWP, to cover activities which are statutorily prohibited from being recovered in this way. ONR also recovers charges for work on the GDA of new reactor designs from the requesting parties. In addition, where appropriate, Government may request significant advice from ONR such as on Advanced Nuclear Technologies (ANTs); this is funded directly from the relevant government department.

L.1.15. In 2019/20, the ONR's total expenditure was £92.3 million, of which total nuclear safety expenditure was £63.3 million ("charged to industry") [135].

Human Resources

L.1.16. ONR employs a total of 659 staff. The majority of these, some 425 staff, are inspectors or technical specialists (i.e. nuclear safety, nuclear security, conventional health and safety, fire safety, transport and safeguards) delivering ONR's core regulatory functions. Around 230 supporting staff deliver functions in finance, programme management and planning and human resources etc. ONR also has a Technical Support Framework (TSF) in place which allows ONR to use external consultants to provide additional technical expertise on projects, as demand requires.

L.1.17. ONR has detailed resourcing plans based on estimates of resource requirements across its regulatory functions over coming years. ONR continues to actively recruit specialist staff externally against these plans to ensure it has a sufficient cadre of inspectors and other staff resource to fulfil expected regulatory demand, and that staffing remains resilience and sustainable in the longer term. Since April 2017, ONR has recruited 94 specialist staff.

L.1.18. ONR has been innovative in recruitment. Experienced personnel have continued to be recruited from within the industry through usual channels. However, to address the demographic challenges in ONR and the wider nuclear industry of an ageing workforce, ONR has successfully taken forward ways to recruit and train younger nuclear professionals.

L.1.19. ONR recruits graduates from the nuclear graduates programme [80], after two years of training within the nuclear industry (including several secondments with licensees and other nuclear-based organisations), as nuclear associates. Nuclear associates and other early career individuals then go through a structured professional development programme to develop them through to becoming inspectors. ONR now also offers five-year degree level engineering apprenticeships as another means to recruit and develop technical specialists.

Staff training within ONR

L.1.20. The ONR Academy is an in-house centre to provide training and development within ONR. It provides all ONR staff with access to high quality training. This includes mandatory core training which all inspectors must take, covering relevant legislation and regulatory approaches. Additionally, the Academy offers an extensive portfolio of courses available in relation to all of ONR's purposes and functions, for instance on technical subjects, such as radiation protection and radioactive waste management, specific aspects of legislation and enforcement, conduct of inspections and investigations, and on softer skills such as effective communication and influencing skills, personal impact and project management. The Academy also runs tutorials, where more experienced inspectors can pass on their knowledge and experience in a focussed way to small groups of less experienced colleagues.

L.1.21. Based on IAEA good practice and the requirements of 'National Occupational Standards for Nuclear Regulators' [136], ONR has developed a regulatory competence framework which defines what the range of competences and skills an ONR inspector is expected to have to deliver the role effectively and competently.

Inspector training

L.1.22. All ONR inspectors have academic and professional qualifications relevant to their specialist discipline on entry into ONR. Most specialist inspectors will have, or be working towards achieving, chartered membership of a relevant professional institution. All inspectors are expected to maintain continuous professional development and receive further training in relation to working as a regulator, inspector and for their technical specialism.

L.1.23. Each inspector has a personal development plan, which captures their training and development needs. This training and development is provided through taking Academy and external training courses, on the job training, and shadowing more experienced inspectors etc. Additionally, inspectors are encouraged to have mentors to provide them with career and professional advice from someone outside of their management chain.

L.1.24. All inspectors must successfully complete mandatory core training to be granted an inspector warrant. On completion of the core training and with sufficient experience of carrying out inspection and specialist work, inspectors are subject to a formal interview to assess whether they meet the requirements to be granted the warrant. Inspectors who hold warrants are assessed for maintaining their warrant through refresher training and examination, every five years.

L.1.25. The performance and competence of inspectors is kept under constant review and is formally reviewed at mid- and end-of-year reviews.

Environment Agencies

L.1.26. The environment agencies in the UK are:

- Environment Agency (for England);
- Scottish Environment Protection Agency (for Scotland);
- National Resources Wales (for Wales); and
- Northern Ireland Environment Agency (for Northern Ireland).

Environment Agency (EA)

Mandate and Duties

L.1.27. The EA was created under the Environment Act 1995 (EA95) with the aim of providing a more integrated approach to protecting and improving the environment of England and Wales as a whole – land, air and water. It is a 'non-departmental public body', sponsored largely by the UK government Department for Environment, Food, and Rural Affairs (DEFRA) and, until 1 April 2013, the Welsh Government. Its powers and duties relate to environmental protection, flood defence, water resources, fisheries, recreation, conservation and navigation. EA95 sets out the principal aim of the EA 'in discharging its functions so to protect or enhance the environment, taken as a whole, as to make the contribution towards attaining the objective of sustainable development'.

L.1.28. The EA is governed by an independent Board that is accountable to the Secretary of State for Environment, Food and Rural Affairs. The Board delegates responsibility for the day-to-day management of the organisation to the EA's Chief Executive. The Board provides the necessary separation between the EA's day-to-day regulatory decision-making and government. The EA is independent of the undertakings that it regulates and has no role in promoting nuclear technology and no responsibilities for developing or operating facilities for radioactive waste disposal or spent fuel management.

Organisational structure

L.1.29. The EA's Radioactive Substances and Installations Regulation Team sets the overall strategy for regulation of radioactive substances activities in England. It leads on support to government on national policy development and implementation, including the development of national waste strategy, as well as regulatory process development.

L.1.30. The EA's specialist Nuclear Regulation Group (NRG) carries out the day-to-day regulation of radioactive waste disposals from the nuclear industry. Regulators working within Area teams of the EA carry out the day-to-day regulation of the non-nuclear use, accumulation and disposal of radioactive substances, including the management of disused / spent radioactive sources (see Section J – Disused Sealed Sources) and wastes, as well as regulating the security of high hazard radioactive sources. Both regulators within the NRG and across non-nuclear teams also address the regulation of transfrontier shipments (see Section I – Transboundary Movement).

L.1.31. The EA's NRG includes two assessment teams providing national support on solid radioactive waste disposal and GDA of new reactor designs, as well as the checking, monitoring and assessment of discharges to the environment. There is also a team providing national support on EA's radiation incident management which provides for 24/7 duty cover by a radiation officer at all times and support to UK radiation incident response arrangements including both nuclear and non-nuclear incidents.

Financial Resources

L.1.32. The EA had a total annual expenditure to March 2019 of £1.4 billion, over half of which was spent on flood and coastal risk management and the balance on environment protection. Its income is derived chiefly from three sources:

- income raised from charging for regulation;
- flood defence levies; and
- government grants, which help to finance amongst other things, pollution prevention and control activities.

L.1.33. Section 41 of EA95 provides the EA with the power to impose financial charges for its regulatory activities in order to recover the expenses incurred through regulation. Such expenses include those incurred in respect of a programme of waste and environmental monitoring carried out by the EA. The EA uses a work-recording system to identify the effort and expenses of its staff attributable to each licensee.

L.1.34. Section 37 of EA95 enables the EA to recover costs associated with advice to organisations that may not currently be licensees or permit holders, for example, to enable advice and support to RWM as part of the GDF programme, and support to the GDA of potential new nuclear build operators.

L.1.35. The EA charges operators for its nuclear regulatory activities on the basis of a daily rate for inspectors. This rate is reviewed periodically. The EA also recharges operators for the monitoring it carries out. Annual charges for nuclear and non-nuclear radioactive substances regulatory work and monitoring activities in the financial year 2019/20 were approximately £19 million.

Human Resources

L.1.36. The EA has a total of about 10,000 staff, although only a small proportion of these are involved in nuclear regulation. The NRG has a total of around 70 nuclear specialists, with additional administrative support. The other groups involved with nuclear regulatory activities, identified above, comprise approximately a further 12 nuclear specialist staff.

L.1.37. The EA currently has sufficient nuclear specialists in post to carry out its regulatory duties but is aware that it needs to actively manage this workforce to ensure that it can continue to do so. Its main challenges are the demography of its workforce, with a significant proportion of experienced staff approaching retirement; the expected growth of several major infrastructure projects that it will need to regulate, such as new nuclear build and geological disposal; and experienced nuclear skills being in short supply nationally.

L.1.38. To meet these challenges the EA is reviewing its workforce planning including recruitment and retention. For example, it has recently revised its pay award for nuclear staff and continues to support a national nuclear graduate scheme. It is also considering the potential benefits of using a new national scheme for degree level apprenticeships.

Inspectors' Qualifications

L.1.39. Nuclear regulatory personnel recruited by the EA are required to have a good honours degree in science or engineering, and often several years' experience in a technical or management role in the nuclear industry, or considerable experience in the regulation of radioactive substances within non-nuclear sectors. The EA uses a 'development grade' to enable recruitment of people into the NRG with other kinds of regulatory experience.

Inspectors' Training

L.1.40. The EA has established standards of competency for its staff involved with the regulation of radioactive substances. Competence standards for nuclear regulation are identified separately within the overall framework.

L.1.41. The standards are used as a benchmark for all staff, but the need to undergo a structured programme depends on the individual's experience. For more experienced staff, the standards are used informally to better target professional development. For new inspectors, attainment of the competency standards is mandatory, and these are used in a formal manner.

L.1.42. Developing the competences of staff is achieved by combination of structured training (such as on legal requirements) and developmental experience (such as on-site inspection or issuing Enforcement Notices). The system adopted by the EA allows for competences to be demonstrated and the standards achieved to be recorded. More experienced staff act as mentors for new staff going through the competences programme.

Scottish Environment Protection Agency (SEPA)

Mandate and Duties

L.1.43. The Scottish Environment Protection Agency (SEPA) was established by the Environment Act 1995 and is Scotland's principal environmental regulator. SEPA is responsible for regulating a wide range of activities including waste, water, contaminated land and industrial emissions as well as radioactive substances activities relating to public exposures in Scotland.

L.1.44. SEPA's statutory purpose is set out in the Regulatory Reform (Scotland) Act 2014 which requires it to carry out its functions for the purpose of protecting and improving the environment, including managing natural resources in a sustainable way. In carrying out these functions, SEPA must contribute to improving the health and well-being of people in Scotland and achieving sustainable economic growth insofar as this is not inconsistent with its regulatory functions.

L.1.45. SEPA independently regulates the management of radioactive waste at nuclear and non-nuclear facilities and the management of radioactive material, including radioactive source security, at non-nuclear facilities in Scotland. Radioactive substances are regulated under EASR18 and the RSA93 (for offshore activities only).

L.1.46. SEPA works with Food Standards Scotland (FSS) on a joint environmental monitoring programme that measures levels of radioactivity in food and the environment in Scotland. The results of environmental monitoring are used to assess public exposures from the consumption of food and doses arising from radioactive waste disposals.

Organisational structure

L.1.47. SEPA is constituted by a Board that is appointed by, and responsible to, the Scottish Ministers. The Board has responsibility for ensuring that SEPA fulfils the aims and objectives set by Scottish Ministers and membership of the Board includes a Chief Executive to whom is delegated the day-to-day management of SEPA.

L.1.48. SEPA's Radioactive Substances Unit is a specialist team of around 25 people who devote their whole time to specialising in all aspects of radioactive substances. This incorporates nuclear and non-nuclear regulation, radioactive substances policy and science functions.

Financial and Human Resources

L.1.49. SEPA has legal powers that allow it to recover costs for the regulation of operators. It also receives finance from the Scottish Government in the form of grant-in-aid for work that is not cost recoverable and from other sources such as a financial agreement with the NDA.

L.1.50. In the financial year 2019/20, SEPA's total income was £83.3 million, of which £37.3 million was grant-in-aid from the Scottish Government.

L.1.51. SEPA has approximately 1300 staff working together to protect and improve the Scottish environment by using a combination of legislation and good practice measures.

L.1.52. SEPA has established a capability assessment matrix for staff in the Radioactive Substances Unit that is based on IAEA good practice, the requirements of 'National Occupational Standards for Nuclear Regulators' [136] and the core syllabus for radioactive waste advisers. The capability assessment matrix defines the range of competences and skills that staff in the Radioactive Substances Unit are expected to have to deliver their role effectively and competently.

L.1.53. All radioactive substances specialists have academic qualifications and experience relevant to their function on entry into SEPA and will receive any additional training needed for them to carry out their function. Additional training needs are identified based on the capability assessment matrix.

L.1.54. The performance and development of staff is kept under continuous review and is formally reviewed through annual personal development reviews.

Natural Resources Wales (NRW)

Mandate and Duties

L.1.55. Natural Resources Wales (NRW) is a Welsh Government sponsored organisation established on 1 April 2013, bringing together the responsibilities, assets and staff from Countryside Council of Wales, Environment Agency Wales and the Forestry Commission Wales.

The role of NRW is to ensure that the environment and natural resources of Wales are sustainably maintained, sustainably enhanced, and sustainably used, now and in the future. This includes being the enforcing authority for the Environmental Permitting Regulations 2016 (EPR16) in Wales.

L.1.56. NRW is the largest Government Sponsored Body in Wales.

Nuclear Regulation

L.1.57. NRW is responsible for the regulation of radioactive substances in Wales and enforcing the requirements of the EPR16. This includes supporting the GDA process, responsibility for regulating the disposal of radioactive wastes and for environmental compliance at nuclear installations.

Financial resources

L.1.58. NRW has a total budget for 2016 to 2017 of approximately £182 million. Income is derived chiefly from Government grants, regulatory charge schemes and commercial income.

L.1.59. NRW charges operators for its nuclear regulatory activities on the basis of a daily rate for inspectors. It also recharges operators for the monitoring it carries out. Annual income for nuclear and non-nuclear radioactive substances regulatory work and monitoring activities in financial year 2016/2017 were approximately £1.78 million.

Human Resources

L.1.60. NRW has approximately 1,800 staff, although only a small proportion of these are involved in nuclear regulation. To ensure NRW maintains access to the right skills, it has a service level agreement with the EA for specific activities relating to the undertaking of nuclear regulation compliance and environmental monitoring activity at nuclear sites in Wales. This is overseen through an intelligent client function within NRW. Permitting and enforcement responsibility lies with NRW.

Northern Ireland Environment Agency (NIEA)

Mandate and Duties

L.1.61. NIEA is responsible under RSA93 for registering and authorising the keeping, accumulation and disposal of radioactive substances in Northern Ireland. This involves the regulation of hospitals, universities, research institutions and industry.

L.1.62. Transport of radioactive substances by road is controlled by NIEA under The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (NI) 2010. NIEA also regulates the shipment of radioactive waste out of Northern Ireland and the shipment of radioactive substances between Northern Ireland and other parts of the EC.

L.1.63. NIEA monitors the impact of radioactive liquid discharges into the Irish Sea on the coastal environment of Northern Ireland.

L.1.64. NIEA co-ordinates radiological emergency planning in Northern Ireland as part of the UK National Plan and the Chief Industrial & Radiochemical Inspector chairs the Northern Ireland Technical Advisors Group (NITAG) which advises departments and Ministers in respect of nuclear emergencies.

Organisational structure

L.1.65. NIEA is an Executive Agency within Northern Ireland’s Department of Agriculture, Environment and Rural Affairs (DAERA). The NIEA sits within the Environment, Marine and Fisheries Group of the Department and is headed by a Chief Executive supported by two Executive Directors with responsibility for the Agency’s two divisions, Natural Environment and Resource Efficiency.

L.1.66. The Industrial Pollution and Radiochemical Inspectorate (IPRI) within Resource Efficiency Division regulates keeping, use and disposal of radioactive material and waste and the transport of radioactive material by road in Northern Ireland. IPRI is headed by the Chief Radiochemical Inspector.

Financial resources

L.1.67. NIEA brings in approx. £28K per year in RSA 1993 subsistence fees.

Human Resources

L.1.68. Within NIEA, 5 technical staff deliver regulatory ionising radiation functions.

Other organisations involved in spent fuel and radioactive waste management

Nuclear Decommissioning Authority

L.1.69. The NDA is a ‘non-departmental public body’ created through the Energy Act 2004 and established in 2005. The NDA is sponsored and funded by BEIS. The responsibilities of NDA are described earlier in the report.

L.1.70. The NDA leads the nuclear clean-up and decommissioning mission on behalf of government and develops the strategy for how it should be carried out. NDA reviews and revises its strategy every 5 years. An updated version of the current 2016 NDA Strategy [9] will be published in 2021.

L.1.71. The NDA uses four themes to describe the different types of clean-up and decommissioning activity: spent fuels, nuclear materials, integrated waste management and site decommissioning and remediation. The NDA mission can be further broken down into 47 outcomes, across the 4 strategic themes.

L.1.72. Since the publication of the sixth UK NR, the NDA has introduced a new way of reporting progress against the mission. NDA mission progress report [17] shows strategic outcomes that NDA needs to achieve in order to complete its mission.

L.1.73. The NDA owns 17 civil nuclear legacy sites across England (12), Wales (2) and Scotland (3), some dating back to the 1940s, including their assets and liabilities (Figure 41) [137]. These sites are described below.

L.1.74. The NDA’s 17 sites include the first fleet of nuclear power stations, research centres, fuel-related facilities, Sellafield and the LLWR, which has the largest radioactive inventory and the most complex facilities to decommission. Current plans indicate it will take 100+ years to complete NDA’s core mission of nuclear clean-up and waste management. The ultimate goal is to achieve the end state at all sites by 2135.

L.1.75. The NDA sites are either wholly owned subsidiaries of the NDA or managed through a Parent Body Organisation (PBO) or other commercial contract (Figure 41). This subsidiary model is intended to provide increased value to the UK taxpayer whilst accessing the expertise from the private sector. At the time of the sixth UK NR, the 12 Magnox Ltd sites were managed through a PBO (Cavendish Fluor Partnership). At the end of March 2017 a decision was made to terminate this contract by mutual agreement after it became clear that there was a mismatch between the work that was specified in the contract and the work that needs to be undertaken to fully decommission the Magnox sites. As a result, on 1 September 2019, Magnox Ltd became a wholly owned subsidiary of the NDA.

L.1.76. NDA also has a number of other subsidiaries, which are responsible for delivering crucial support and enabling activities. These include:

- Radioactive Waste Management Ltd, which is responsible for the mission to deliver a GDF;
- Direct Rail Services and International Nuclear Services, which provide transport services for the NDA estate; and

- NDA Archives Limited, responsible for managing nuclear records and information (including operating the national archive, Nucleus);

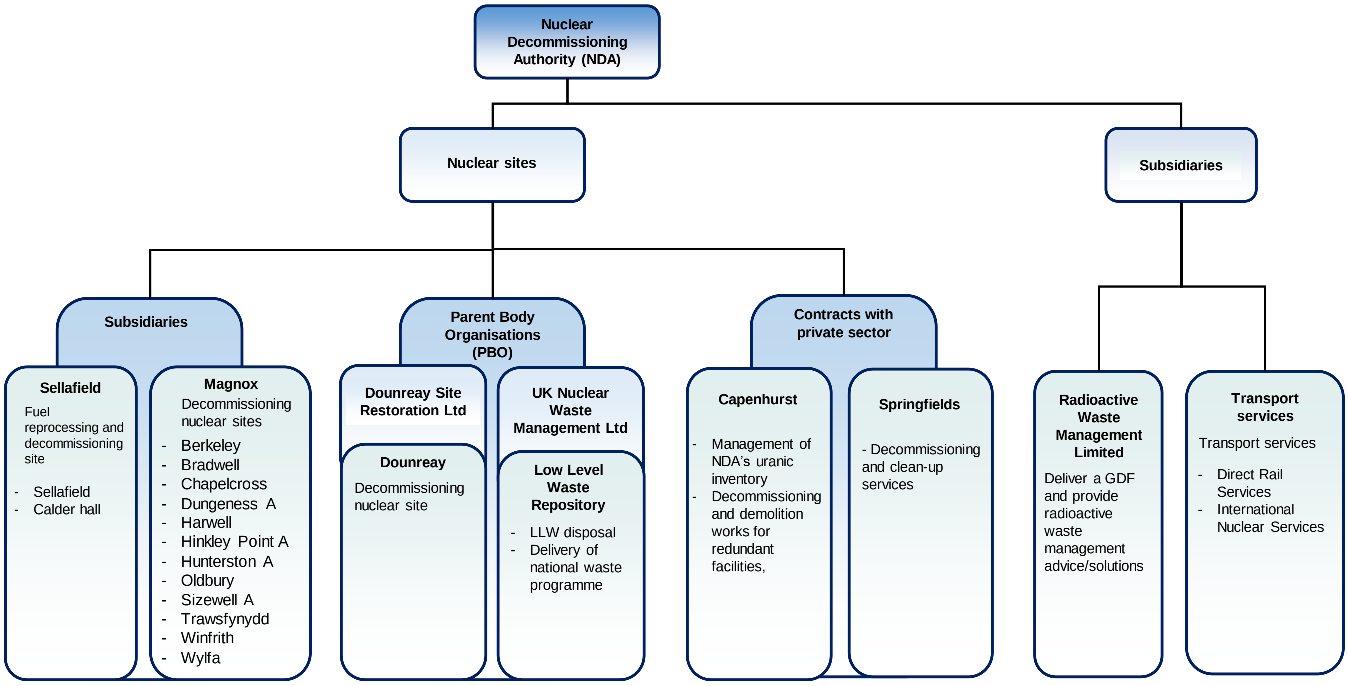


Figure 81: NDA nuclear sites and subsidiaries

L.1.77. The businesses charged with operating the NDA sites are called site licence companies (SLCs). A SLC holds the nuclear site licence, granted by the ONR, to operate the nuclear site(s), together with other permits or authorisations issued by the relevant environment agency.

L.1.78. The clean-up work of the NDA is principally delivered through four site licence companies: Sellafield Ltd and Magnox Ltd are wholly owned subsidiaries of the NDA, while DSRL and LLWR Ltd are managed by PBOs with which the NDA has a contract.

L.1.79. In addition, the NDA has decommissioning contracts and other commercial arrangements in place with private sector organisations (including Springfields Fuels Limited and Urenco at Capenhurst), to act as the site licence holder and manage NDA-owned nuclear material and provide decommissioning and clean-up services.

Budget

L.1.80. The NDA is publicly funded through BEIS. The total planned expenditure is voted upon annually by Parliament, in line with the Spending Review.

L.1.81. The NDA Business Plan [137] is published annually. The Business Plan describes key activities across the NDA group over the next three years that align to the NDA strategic outcomes and details the funding available for the next year.

L.1.82. The latest Business Plan sets out the NDA's anticipated income and expenditure for 2020/21 as agreed with Treasury and BEIS.

L.1.83. The NDA's total planned expenditure for 2020/21 is £3.391 billion; of which £2.785 billion will be funded by UK government and £0.606 billion by income from commercial operations. Planned expenditure on site programmes will be £3.140 billion, while non-site expenditure is expected to be £0.251 billion.

Radioactive Waste Management Ltd.

L.1.84. The NDA has a responsibility for implementing geological disposal for High-Activity Waste (HAW) and has established RWM as the geological disposal delivery organisation. Reflecting its responsibilities, RWM's mission statement is to "deliver a GDF and provide radioactive waste management solutions".

L.1.85. RWM updated its corporate strategy [138] in 2019. This document sets out RWM's vision, mission and values, and the factors on which RWM based its strategic approach.

L.1.86. RWM has responsibility for planning and ultimately implementing geological disposal of HAW, in accordance with the UK government policy. This includes ensuring such wastes generated throughout the UK are conditioned and packaged in a manner suitable for eventual disposal. In order to discharge this responsibility RWM is developing plans for the implementation of geological disposal using an iterative disposal system development process. In this process, the Disposal System Specification incorporates external requirements to guide the Design and Safety Assessment processes, which in turn leads to refinements and changes in the specification.

L.1.87. In advance of the availability of a GDF, RWM provides advice on the packaging of HAW for geological disposal. This is generally undertaken via the disposability assessment Process (also known as the LoC process). The primary aim of which is to minimise the risk that the conditioning and packaging of radioactive wastes results in packages incompatible with geological disposal, as far as this is possible in advance of the availability of Waste Acceptance Criteria for a GDF. As such, it is an enabler for early hazard reduction on all UK nuclear sites. Disposability advice is provided to support development of strategic options for spent fuel, plutonium and uranics, as well as the GDA process for new build reactors. Disposability advice is provided to the UK nuclear industry and other waste producers. The disposability assessment Process is supported by a suite of waste package specification and associated guidance documentation [31].

L.1.88. RWM also take on a role of HAW Integrator, providing support to the NDA strategy and supporting waste producers through the provision of technical advice, sharing relevant experience and collaborating on work to realise opportunities connected to the whole lifecycle of the waste.

Advisory Bodies

L.1.89. The UK government and devolved administrations utilise independent advice from various advisory and expert groups to develop a policy and strategy and to receive independent opinion on their implementation. The main advisory bodies are described below.

Nuclear Decommissioning Strategy and Policy Group

L.1.90. The Nuclear Decommissioning Strategy and Policy Group (NDSPG) is an advisory group chaired by BEIS and attended by devolved administrations, NDA, ONR, the environment agencies, MoD and UK Government Investments. Its work is supported by a number of expert groups, including four Thematic Overview Groups covering site decommissioning and remediation, spent fuel and nuclear materials, integrated waste management and "critical enablers" (i.e. topics critical to the delivery of the NDA mission).

L.1.91. The purpose of the NDSPG is to provide advice and guidance to the NDA on the development, adequacy and implementation of its strategies, promote and steer collaborative work to realise strategic opportunities in relation to public nuclear liabilities and mitigate significant threats and/or blockers. It oversees projects in place to realise strategic opportunities to accelerate hazard and risk reduction through decommissioning and clean-up programmes and provides input into the formal governance processes of its member organisations.

Radioactive Substances Policy Group

L.1.92. The Radioactive Substances Policy Group (RSPG) was established to provide strategic oversight across the UK on the development and delivery of relevant policy, legislation and regulation. It can also act, where appropriate, as a Programme Board for the development, review and delivery of policy, legislative and regulatory activities. The core group membership includes policy owners (BEIS and devolved administrations) and regulators (ONR and environment agencies).

Nuclear Industry Council

L.1.93. The Nuclear Industry Council (NIC) [139] is a joint forum between the nuclear industry and UK government. Its primary role is to provide strategic leadership to the nuclear industry. The NIC is primarily responsible for overseeing the delivery of the NSD and addressing the key strategic issues for the nuclear sector, with working groups on new build cost reduction, legacy cost reduction, winning UK business, skills and diversity and innovation and research and development.

Safety Directors' Forum

L.1.94. The Safety Directors' Forum (SDF) [140] is a voluntary organisation, supported by the Nuclear Institute, comprising senior level nuclear executives - safety directors and directors of companies with major nuclear interests.

L.1.95. The main objectives of the SDF are to promote continuous learning and improvement in safety and environmental protection across the UK nuclear industry through sharing good practice and guidance and to agree strategy on addressing key issues facing the industry.

Store Operations Forum

L.1.96. The Store Operations Forum (SOF) is a cross-industry group containing representatives from the NDA, RWM, waste producers and store operators. It provides a forum for sharing operational experience, identification of generic research requirements to inform strategy development and sharing good practice in relation to the storage of containerised HAW and to provide expert advice to inform relevant NDA strategies. The SOF contributes to the NDA guidance on the interim storage of HAW packages [34] to ensure it presents good practice.

Committee on Radioactive Waste Management

L.1.97. The Committee on Radioactive Waste Management (CoRWM) [141] is an advisory, non-departmental public body, sponsored by BEIS. It comprises of experts in radioactive waste management who are appointed by BEIS and the devolved administrations. In the interests of openness and transparency, CoRWM holds plenary meetings which are open to the public and publishes its meeting reports and position papers.

L.1.98. CoRWM provides independent scrutiny and advice to the UK government and devolved administrations on the long-term management of higher activity radioactive wastes (HAW). This remit of the group includes providing independent scrutiny and advice in relation to policy, strategy and programmes for the long-term management of HAW, including interim storage and geological disposal.

Committee on Medical Aspects of Radiation in the Environment

L.1.99. The Committee on Medical Aspects of Radiation in the Environment (COMARE) [142] is a Department of Health and Social Care expert committee. It provides independent advice to all government departments and agencies on the health effects of natural and man-made ionising and non-ionising radiation. COMARE holds open meetings which the public can attend.

Legislative and Regulatory Framework for Transportation of Spent Fuel and Radioactive Waste

L.1.100. The regulatory requirements for transportation of spent fuel and radioactive waste depend on the mode of transport and, for some modes, the country that they are being transported in. The following sections describe the regulatory requirements for the differing modes of transport, namely:

- road, rail or inland waterway;
- sea; and
- air.

Radioactive Materials (RAM) Transport by Road, Rail or Inland Waterway

L.1.101. For civil transport of Class 7 goods (radioactive material) by road and rail in Great Britain, legislation for regulation of the transport of radioactive materials has been brought together with the legislation for nuclear safety under TEA13 [143]. The principal legislation for ensuring the safety of radioactive material transport has already been summarised as follows:

- TEA13 [143]; and
- Health and Safety at Work Act 1974 [58].

L.1.102. The regulatory framework for RAM transport is based on the following regulations, which are secondary legislation made under TEA13:

- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG09) [144];
- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment (Amendment) Regulations 2011 [145];
- The Carriage of Dangerous Goods (Amendment) Regulations 2019 [146]; and
- Ionising Radiation Regulations (2017) [85].

L.1.103. CDG09 implements the following international agreements and regulations directly by referring to the current version as revised or reissued from time to time:

- European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR);
- Regulations concerning the International Carriage of Dangerous Goods by Rail (RID); and
- European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterway (ADN) but only sub-sections 1.8.3.7 to 1.8.3.16.

L.1.104. As well as implementing the ADR, RID and ADN, the above regulations set out requirements for preparing for, and responding to, potential radiological emergencies during the carriage of radioactive material (RAM). The regulations place duties upon everyone involved in the carriage of dangerous goods to ensure that they know what they have to do to minimise the risk of incidents and guarantee an effective emergency response.

L.1.105. The regulatory body for civil transport of RAM by road, rail and inland waterway in Great Britain is the ONR, although in practice inland waterways are not used for transporting RAM. Inspection and enforcement powers for road and rail transport derive from TEA13 (in relation to CDG09) and HSWA74 (in relation to IRR17) and are the as for nuclear safety as described above.

L.1.106. The regulatory body for defence related transport of radioactive material by road, rail and inland waterway transport in Great Britain is the MoD for CDG09 and HSE for IRR17.

L.1.107. There is an analogous situation in Northern Ireland, where the regulations also implement the latest version of ADR, RID and ADN through the following regulations made under the Health and Safety at Work (Northern Ireland) Order 1978 (HSW(NI)O78) [147]:

- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (Northern Ireland) 2010 [148];

- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment (Amendment) Regulations (Northern Ireland) 2011 [149]; and
- The Ionising Radiations Regulations (2017) and the Ionising Radiations Regulations (Northern Ireland) 2017 [86].

L.1.108. The regulatory body for CDG(NI)10 for road, transport in NI is NIEA, while for rail and inland waterways it is HSENI. The regulatory body for IRRNI17 for road, rail and inland waterway transport in NI is HSENI.

L.1.109. The Department of Agriculture, Environment and Rural Affairs (Northern Ireland) (DAERA) derives its inspection and enforcement powers from HSW(NI)O78 and these are broadly similar to the powers that the ONR derives from HSWA74 as described above.

RAM Transport by Sea

L.1.110. The principal legislation for RAM transport for British registered ships and all other ships while in UK territorial waters is contained within the Merchant Shipping Act 1995 (MSA95) [150], which is enforced by the Maritime and Coastguard Agency (MCA). The MCA have an enforcement policy statement [151].

L.1.111. Regulatory requirements for RAM transport by sea are based on the following:

- The Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997 [118], which were made under MSA95 and HSWA74; and
- Merchant Shipping Notice (MSN) 1893 (M) The Carriage of Dangerous Goods and Marine Pollutants in Packaged Form: Amendment 39-18 to the International Maritime Dangerous Goods (IMDG) Code [152] issued by the MCA.

L.1.112. These requirements implement the International Maritime Organisation's (IMO) IMDG Code Amendment 39-18 directly by referencing it from within the legislation.

L.1.113. For spent fuel, the regulatory requirements are in:

- Merchant Shipping (Carriage of Packaged Irradiated Nuclear Fuel etc.) (INF Code) Regulations 2000, SI 2000/ 3216 [153].

L.1.114. These regulations give effect to the International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships (the INF Code), and SOLAS chapter VII Part D, Regulation 4.

L.1.115. Under MSA95, legislation allows the MCA to board ships and carry out inspections. The power of inspection is derived from the MSA95.

L.1.116. MSA95 provides the surveyors appointed by the Secretariat of State for Transport with the powers to detain ships and issue Prohibition Notices and Improvement Notices.

L.1.117. Under the Merchant Shipping Act and the various SIs, depending upon the method of carriage, the MCA have the powers to prosecute owners/charters/Master etc. when they do not comply with any section of the applicable SI.

L.1.118. The responsibility for the approval of designs and activities for the carriage of radioactive material by sea is with the MCA. However, ONR approves higher hazard designs and activities on behalf of MCA i.e. those legally requiring CA approval (e.g. Type B or fissile packages) under the agency agreements. MCA survey the vessels and stowage and segregation requirements to ensure they comply with the requirements of the applicable IMO Conventions.

L.1.119. The Merchant Shipping (Port State Control) Regulations 2011 [154] implement Directive 2009/16/EC. The Directive provides a regime for the enforcement, in respect of shipping using ports in Member States of the EU and their waters, of international standards for ship safety, pollution prevention and shipboard living and working conditions. The Directive is extended to the EEA.

L.1.120. The Merchant Shipping (Survey and Certification) Regulations 2015 [155] make provisions for the inspections and surveys to be carried out on UK ships wherever they may be, and also on other ships while in UK waters. The regulations give effect to the requirement as to surveys and the issue of certificates contained in the Safety of Life at Sea Convention 1974, as amended, and also contain similar requirements for ships not subject to the Convention.

RAM Transport by Air

L.1.121. The UK requirements for RAM transport by air, which are enforced by the Civil Aviation Authority (CAA), are specified by the following made under the Civil Aviation Act 1982 [156]:

- The Air Navigation Order 2016 [157];
- The Air Navigation (Dangerous Goods) Regulations 2002 [158]; and
- The Air Navigation (Dangerous Goods) (Amendment) Regulations 2019 [159].

L.1.122. These implement the Technical Instructions for the Safe Transport of Dangerous Goods by Air 2019-2020 issued by the International Civil Aviation Authority’s (ICAO) by referencing them directly from within the legislation.

L.1.123. Inspection and enforcement powers for air transport derive from the Civil Aviation Act 1982 [156] and associated regulations listed above. These powers enable audits and inspections concerning all activities associated with dangerous goods in air transport including acceptance, loading and carriage by the aircraft operator or its designated agent. The CAA also performs risk and performance-based oversight (audits) of shippers and freight forwarders. Where necessary, the CAA works with the ONR (which has the power to enter the premises of such organisations) as a shipment suspected to be in breach of the Air Navigation (Dangerous Goods) Regulations is likely to be in breach of the regulations applicable to surface transport when carried to or from the airport. The CAA is tasked by the Department for Transport to investigate and prosecute breaches of aviation safety rules, including dangerous goods offences.

L.1.124. In response to non-compliance the CAA may issue a warning letter, audit finding or suspend/revoke a UK air operator’s approval for the transport of dangerous goods by air. Serious one-off or repeated non-compliance can lead to criminal prosecution.

UK legislative framework relevant to the Joint Convention

L.1.125. The tables below summarise the key legislation relevant to the safe management of spent fuel and radioactive waste (nb the lists are not exhaustive of all extant legislation).

Table 7: Legislative framework for general health and safety and occupational exposures (some relevant legislation listed; not an exhaustive list)

Acts of parliament & Regulations;	Guidance
Health and Safety at Work etc. Act 1974 Health and Safety at Work (Northern Ireland) Order 1978 (HSW(NI)O78) Ionising Radiations Regulations 2017 (IRR17) Ionising Radiations Regulations (Northern Ireland) 2017 (IRRNI17) Management of Health and Safety at Work Regulations 1999 Pressure Systems Safety Regulations 2000 (PSSR). Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 2018 Control of Substances Hazardous to Health Regulations 2002 (COSHH) Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR)	ACoP and guidance for IRR17 and IRRNI17 Safe use of lifting equipment: Lifting Operations and Lifting Equipment Regulations 1998. ACoP and guidance Guidance on the Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations

Table 8: Legislative framework for nuclear safety

Acts of parliament & Regulations	Guidance
Nuclear Installations Act 1965 The Energy Act 2013 Nuclear Installations Regulations 1971 (NIR) The Nuclear Installations (Dangerous Occurrences) Regulations 1965	ONR Guidance

Table 9: Legislative framework for environmental protection

Legislative framework	Guidance
Environmental Protection Act 1990 Environment Act 1995 Radioactive Substances Act 1993 Food Standards Act 1999 The Ionising Radiation (Basic Safety Standards) (Miscellaneous Provisions) Regulations 2018 Environmental Permitting (England and Wales) Regulations 2016 as amended Environmental Authorisations (Scotland) Regulations 2018 Radioactive Contaminated Land (Scotland) Regulations 2007The Transfrontier Shipment of Radioactive Waste and Spent Fuel Regulations 2008 The Radioactive Substances (Basic Safety Standards) Regulations (Northern Ireland) 2003 The Radioactive Contaminated Land Regulations (Northern Ireland) 2006 The Radioactive Substances Exemption Northern Ireland) Order 2011 & The Radioactive Substances (Modification of Enactments) Regulations (Northern Ireland) 2018 Waste and Contaminated Land (Northern Ireland) Order 1997 and the Hazardous	EA, NRW, SEPA, NIEA Guidance Defra Guidance on Environmental Permitting

Legislative framework	Guidance
Waste Regulations (Northern Ireland) 2005	

Table 10: Legislative framework for the transport of radioactive materials

Legislative framework	Guidance
Road, Rail and Inland Waterways in GB: Energy Act 2013 The Energy Act 2013 (Office for Nuclear Regulation) (Consequential Amendments, Transitional Provisions and Savings) Order 2014 (SI 2014 No. 469) Health and Safety at Work etc. Act 1974 & Road, Rail and Inland Waterways in NI: Health and Safety at Work (Northern Ireland) Order 1978) The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 as amended '& The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (Northern Ireland) 2010 as amended Ionising Radiations Regulations 2017 & Ionising Radiations Regulations (Northern Ireland) 2017	ONR Guidance
Merchant Shipping Act 1995 (MSA95 & The Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997, Merchant Shipping (Carriage of Packaged Irradiated Nuclear Fuel etc.) (INF Code) Regulations 2000	MCA guidance
Civil Aviation Act 1982 & The Air Navigation Order 2016; The Air Navigation (Dangerous Goods) Regulations 2002; and The Air Navigation (Dangerous Goods) (Amendment) Regulations 2017	CAA guidance

Table 11: Legislative framework for emergency preparedness and response

Legislative framework	Guidance	Regulator
Civil Contingencies Act 2004 Radiation (Emergency Preparedness and Public Information) Regulations 2019 & Radiation (Emergency Preparedness and Public Information) Regulations (Northern Ireland) 2001. The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 as amended & The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (Northern Ireland) 2010 as amended The Food and Feed (Maximum Permitted Levels of Radioactive Contamination) (Amendment) (EU Exit) Regulations 2019[1]	EA, SEPA, NRW and NIEA emergency response guidance EA, SEPA, NRW and NIEA emergency response guidance HSE Guidance & ONR Guidance Cabinet Office Guidance UK and Scottish Government guidance, including "Preparing for and responding to energy emergencies" and "Preparing Scotland" and PHE guidance	The requirements in REPPIR 19 and the Radiation (Emergency Prepared-ness and Public Information) Regulations (Northern Ireland) 2001 require coordination and cooperation between all State agencies that may have a role in emergency response

Section L.2 – Lists and Inventories

L.2.1. This section provides the following lists and inventories referred to in Section D - Inventories and Lists:

- Spent Fuel Management Facilities;
- Inventory of Spent Fuel;
- Radioactive waste Management Facilities;
- Inventory of Radioactive Waste; and
- Decommissioning facilities.

L.2.2. The map below (Figure 42) shows all of the facilities regulated by the ONR, which includes the majority of those listed in this report to the JC. The exceptions being some (V)LLW disposal sites which are not licensed by ONR but have permits issued by the relevant environment agency.

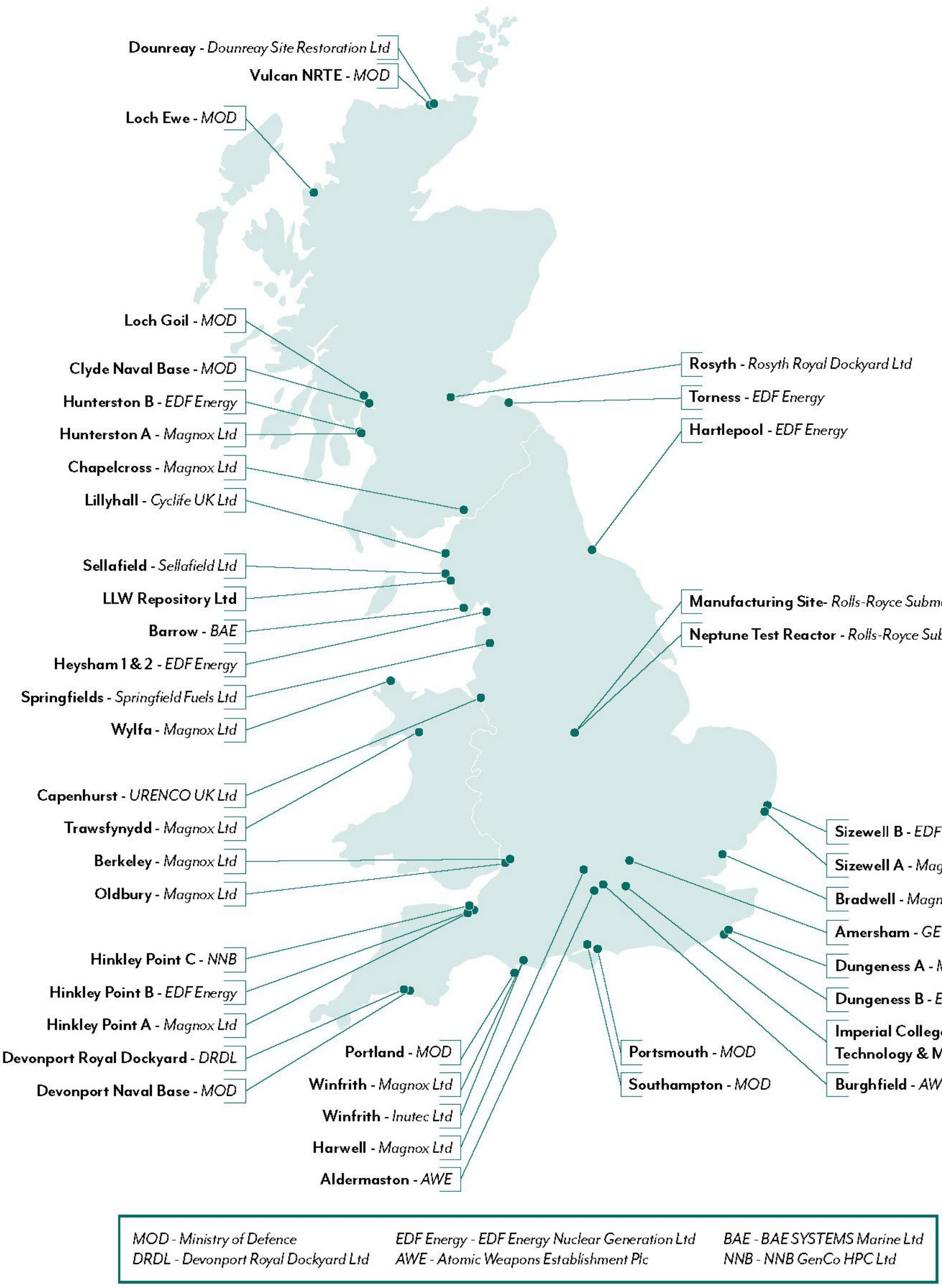


Figure 83: Map of sites regulated by the ONR in Great Britain

Spent Fuel Management Facilities

Storage of Spent Fuel at Reactor Sites

Magnox Ltd & AGR Reactor Sites

L.2.3. In 2019 a significant UK milestone was marked with the final removal of all Magnox spent fuel from the last two UK Magnox reactor sites at Wylfa and Calder Hall. All of the remaining spent

Magnox fuel now resides in the cooling pond at the Fuel Handling Plant or in FGMSP on the Sellafield site.

L.2.4. Each operating AGR station has one fuel storage pond. On removing spent fuel from the reactor core the fuel is dry-stored for a short period in a carbon dioxide atmosphere prior to its transfer to the storage pond. In due course it is then put into a spent fuel transport flask and dispatched to Sellafield for long-term storage.

Sizewell B PWR

L.2.5. Sizewell B has a projected lifetime of at least 40 years, which equates to an assumed closure date of 2035. Although there is the potential for lifetime extension to 2055 subject to the normal regulatory approvals. The PWR spent fuel will be stored on site until a GDF is available. As the site's fuel storage pond does not have sufficient capacity to hold all of the spent fuel that will arise over the operational lifetime of the power station, a Dry Store was constructed and has been receiving spent fuel containers since early 2017.

L.2.6. Proprietary multi-purpose containers are used to store the spent fuel within the Dry Store. Each container holds 24 spent fuel assemblies. If the station's operational life is extended from 40 to 60 years, approximately 150 containers will be required. Each container is stored within a shielded over-pack. The transfer of the spent fuel that is initially stored in the station pond to the Dry Store is facilitated by a range of transport and handing equipment and associated ancillary components, including a purpose-built flask. The fuel containers maintain an inert gas atmosphere around the spent fuel assemblies for the full duration of storage in the Dry Store. Decay heat is dissipated through the external surface of the containers and cooling of the building is achieved by natural convection.

L.2.7. The station's entire lifetime accumulation of spent fuel will be progressively moved into dry storage following the end of generation. Thereafter, the Dry Store will operate until the spent fuel is retrieved at a date dependent on the availability of a disposal route, which is currently planned to be the proposed GDF. For planning purposes, the transfer of fuel to a GDF has been assumed by EDF(NG) to commence around 2080, with decommissioning of the Dry Store over a two-year period commencing in 2100.

Storage of Spent Fuel at Other Sites

Dounreay

L.2.8. Fuel is currently located in three facilities at Dounreay. Breeder fuel elements are currently located in the DFR vessel and are being retrieved for reprocessing at Sellafield. Once this route is not available, the remainder of the breeder elements will be packaged for storage on the Sellafield site. The remaining PFR fuel is currently dry stored in the Irradiated Fuel Cave. The intention is for this material to be packaged for transport and storage at Sellafield. The remainder of the irradiated fuel is stored in a shielded cave that was previously used for the examination of irradiated fuel. Options are being explored to relocate this fuel to Sellafield.

Sellafield

L.2.9. Sellafield has several spent fuel cooling ponds (cooling pools), which have been used in support of spent fuel reprocessing operations or for interim storage of spent fuel pending a decision on its disposition. These are:

- Pile Fuel Storage Pond. This is the oldest storage pond on the Sellafield site, which, from around 1952, was used to store and cool spent fuel from the Windscale pile reactors. It was later used until around 1960 for spent Magnox fuel from the Calder Hall nuclear power station. The pond has been cleared of bulk spent fuel and work is on-going on to empty the pond of all other radioactive waste;

- First Generation Magnox Storage Pond. This pond was used between 1960 and 1986 to store and de-can (i.e. remove the fuel cladding) spent fuel from the UK's Magnox nuclear power stations (and some spent fuel from other countries). Work is on-going to remove all bulk fuel and other radioactive material from the pond;

- First Generation Oxide Fuel Storage Pond (FGOSP). This pond and several associated bays were used between around 1968 and 2004 for the receipt and storage of spent oxide fuel, including fuel to be reprocessed in THORP. The pond is still operational. It has limited fuel inventory at the moment, but still receives fuel in Multi-Element Bottles (MEBs) from THORP Receipt and Storage Pond;

- Fuel Handling Plant (FHP) pond. This pond has been used since 1984 to store and cool spent Magnox and AGR fuel and to remove the fuel cladding. Spent Magnox fuel which has not been reprocessed is stored in the pond pending a future decision on its disposition. The AGR fuel is subsequently transferred to the THORP Receipt and Storage Pond;

- THORP Receipt and Storage Pond. This pond was used since 1988 as a short-term buffer store for spent AGR fuel prior to reprocessing in THORP. Since the cessation of reprocessing in THORP in 2018, TR&S is now used as an interim store for spent AGR fuel pending a decision on its disposition;

- First Generation AGR Storage Pond (FGASP). This pond has been used since 1982 for the temporary storage of dismantled AGR fuel from FHP before subsequent dispatch to the TR&S for processing through THORP. The pond is still operational and is a key operational part of the AGR flask moves.

Reprocessing Facilities

L.2.10. The first reprocessing plant at Sellafield operated from 1952 to 1964. This reprocessed defence fuel from the Windscale Piles and fuel from the first Magnox reactors. This plant was modified to gain experience in oxide fuel reprocessing and performed that function from 1969 to 1973 on spent fuels from WAGR, the Steam-Generating Heavy Water Reactor (SGHWR) and from overseas customers.

Sellafield – the Magnox Reprocessing Plant

L.2.11. The Magnox Reprocessing Plant was commissioned in 1964 to reprocess spent Magnox fuel. It is scheduled to complete its reprocessing operations in 2020/21.

L.2.12. Liquid effluent from the stages of reprocessing are treated in separate plants according to their level of radioactivity. Fission products are concentrated by evaporation, and then stored, prior to being vitrified and placed into containers for long-term storage.

Sellafield – Thermal Oxide Reprocessing Plant

L.2.13. From 1994 to 2018 THORP reprocessed irradiated oxide fuel, primarily from AGR and LWR reactors. The facility is now entering its POCO stage.

Dounreay – MTR Reprocessing Plant

L.2.14. From 1961 to 1997 this plant reprocessed irradiated Materials Test Reactor (MTR) fuel from the UK and overseas MTRs. The facility which includes a fuel handling pond has been partially decommissioned.

Dounrey – Fast Reactor Fuel Reprocessing Plant

L.2.15. From 1960 to 1977 this plant reprocessed irradiated fuel from DFR. The facility was modified and equipment to handle and dismantle the PFR MoX fuel and a plutonium evaporation and export annex were added in the late 1970s to allow concentrated plutonium nitrate to be transported to Sellafield for re-use in future fuel. The refurbished plant reprocessed the fuel from PFR until the main dissolver failed in 1994. The facility is in its POCO stage.

Radioactive Waste Management Facilities

Article 32.2: This report shall also include:

(iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;

Sellafield

L.2.16. Sellafield comprises more than 250 nuclear facilities and over 1000 buildings, with a wide diversity in plant and facilities, reflecting the site's long and varied operational history. Its main radioactive waste management facilities are described below.

L.2.17. There are also some nuclear reactors on the Sellafield site, which are all undergoing decommissioning:

- Calder Hall nuclear power station, the first industrial scale nuclear power station to be connected to the national grid. This station, consisting of four Magnox reactors, is fully defueled and is undergoing decommissioning;
- WAGR, a prototype reactor, closed down in 1981 and now largely decommissioned;
- Windscale Piles 1 and 2, reactors used in the 1950s to produce plutonium and undergoing decommissioning.

Waste Monitoring and Compaction Plant (WAMAC)

L.2.18. WAMAC is a high force compaction plant designed to receive, process and compact solid LLW from the Sellafield Site. After compaction, the waste is placed into product containers for despatch to the LLWR. In addition, the facility provides a service to other waste producers to receive compactable and non-compactable waste for consignment to the LLWR. Monitoring is conducted to demonstrate conformance with conditions for acceptance at the LLWR.

Waste Treatment Complex (WTC)

L.2.19. WTC processes PCM, including historical waste arising from ongoing work activities at Sellafield and Harwell. Drums with a capacity of 200L are filled with PCM and super-compacted. Typically an average of six of the resulting compacted 'pucks' are placed in larger, 500L capacity stainless steel drums, which are then in-filled with a cement grout, before being transported to a dedicated store. More effective characterisation of PCM has allowed some PCM to be re-categorised as LLW.

Magnox Encapsulation Plant (MEP)

L.2.20. MEP receives metallic cladding debris (swarf) produced during the de-canning of Magnox fuel at Sellafield. It has also received legacy Magnox cladding material that had previously been stored in bulk underwater in large silos elsewhere on the Sellafield site. Cladding from either source is tipped into 500L capacity stainless steel drums, which are then in-filled with a cement grout matrix and placed in HAW stores.

Waste Encapsulation Plant (WEP)

L.2.21. WEP encapsulates waste fuel cladding and slurries that arise from the reprocessing of oxide fuels in THORP. In addition, WEP has recently started to encapsulate sludges from the PFSP in support of the Sellafield decommissioning and clean-up programme. Similar to the process employed in MEP, the waste cladding is placed in 500L capacity stainless steel drums, then in-filled with cement grout and subjected to in-drum mixing, prior to being placed in HAW stores.

Waste Processing and Encapsulation Plant (WPEP)

L.2.22. Flocs generated by the actinide liquid effluent clean-up plant are encapsulated in WPEP using the same in-drum mixing technique used in WEP and a similar 500L drum design.

Liquid Effluent Treatment Plants

L.2.23. The management of radioactive liquid effluents at Sellafield takes place in a suite of treatment plants including; the Enhanced Actinide Removal Plant (EARP), the Solvent Treatment Plant (STP), the Salt Evaporator Plant (SEP), the Separation Area Lagoon, the Medium Active Liquor Tank Farm and the Segregated Effluent Treatment Plant (SETP)

L.2.24. The Sellafield Ion Exchange Plant (SIXEP) uses a combination of filtration and ion exchange beds to remove suspended fine solids, soluble radioactive caesium and strontium from pond water prior to discharge. SIXEP has dedicated stores for the solid waste generated from its own processes and also helps maintain the thermal conditions of the pond water in the Fuel Handling Plant.

L.2.25. Future plans include:

- the development of a SIXEP Continuity Plant (SCP), which is ultimately expected to replace SIXEP's capability, as the site's effluent treatment requirements change; and
- diversion of effluent streams to EARP (away from SETP) following the cessation of reprocessing, allowing abatement of these discharges.

Future Treatment Plants

L.2.26. A number of new treatment and storage plants have been built or are under construction at Sellafield, principally to support the retrieval of legacy wastes from the Legacy Ponds and Silos (LP&S). These include:

- Local Sludge Treatment Plant (LSTP) which is now being used to support the export of sludge from PFSP to WEP for conditioning;
- SPP1 which is now being used for the interim storage of sludge retrieved from FGMSP;
- Self-Shielded Box Interim Store Facility, which is to be used to interim store legacy ponds solids;
- Box Encapsulation Plant (BEP) which is being constructed to treat HAW from legacy facilities; and

- Box Encapsulation Plant Product Stores (BEPPS) which is being constructed to store unconditioned (“raw”) and conditioned wastes from legacy facilities on the site.

Engineered Storage for Conditioned Wastes

L.2.27. Sellafield features a series of modern stores for conditioned PCM wastes, miscellaneous solids, vitrified HAL, encapsulated Magnox swarf, THORP hulls and sludge, and encapsulated waste from the on-site effluent treatment plants.

Interim PCM Drum Storage, Unconditioned Waste

L.2.28. A significant quantity of unconditioned PCM is currently stored in modern standard stores at Sellafield pending conditioning in a waste treatment plant and transfer to the engineered drum stores described above.

Spent Fuel Cooling Ponds

L.2.29. The non-operational spent fuel cooling ponds, in particular FGMSP and PFSP, contain accumulations of radioactive waste, including sludge, fuel skips and other pond furniture. Work is on-going to retrieve these wastes for safe storage in dedicated stores, pending future disposal.

Magnox Swarf Storage Silo (MSSS) and Pile Fuel Storage Silo (PFCS)

L.2.30. MSSS and PFCS are silos currently storing significant inventories of fuel cladding material and other miscellaneous solid ILW. Programmes of work are progressing to retrieve the radioactive waste in these silos and package it for safe storage in more modern stores.

ILW Tanks

L.2.31. Liquid and sludge wastes are stored in a number of tanks and vessels on the site. These either form part of existing waste treatment processes or hold historic wastes awaiting a treatment process. In all cases, treatment plants exist or are planned to condition the waste into a solid form for storage in engineered stores.

Miscellaneous Beta-Gamma waste Store

L.2.32. The miscellaneous beta-gamma waste store (MBGWS) is used to store beta-gamma radioactive waste, including waste retrieved from the legacy ponds FGMSP and PFSP.

Highly-Active Liquid (HAL) Wastes and Vitrification

L.2.33. Sellafield concentrates and stores the Highly-Active raffinates that arise from the reprocessing of nuclear fuel. New evaporative capacity is being provided to support the cessation of reprocessing and POCO activities. The ONR’s regulatory strategy with regards to the HAL stocks at Sellafield is described in Section E – Legislative and Regulatory System.

Calder Landfill Extension Segregated Area

L.2.34. CLESA is a landfill disposal site, licensed by the EA and constructed to modern standards for environmental protection, located within the Sellafield nuclear licenced site. Its purpose is to enable disposal of specified LLW and certain non-radioactive waste which otherwise would have to be disposed of at other licensed disposal sites within the UK. These wastes arise predominantly from decommissioning activities taking place at Sellafield.

Active Handling Facility

L.2.35. The Active Handling Facility is an operational post-irradiation examination facility for nuclear reactor fuel, which is also used for the treatment and packaging of LLW and ILW, and the handling of redundant radioactive sources.

WAGR Packaging Plant and Box Store

L.2.36. The WAGR Box Store provides interim storage for shielded boxes of waste from the decommissioning of WAGR. LLW is held pending transfer to the LLWR for disposal, and the ILW (and some LLW that is unsuitable for disposal to the LLWR) is stored pending an alternative long-term strategy or availability of a GDF. An improvement in waste packing efficiencies achieved by the WAGR project has made spare capacity available within the store.

Low-Level Waste Repository (LLWR)

L.2.37. The LLWR is the UK's only waste disposal facility for LLW. It is a surface disposal facility covering around 300 acres, near Sellafield. Between around 1959 and 1995, wastes were disposed of in clay-lined trenches, which are now protected by an interim cap. Since the late 1980s, waste disposed of at the LLWR is placed in metallic Intermodal Shipping Containers (ISO). Any void space inside the containers is minimised by filling with grout at the LLWR and the containers are emplaced in engineered concrete-lined near-surface vaults. The LLWR currently has 9 vaults, with possibly up to a further 6 vaults planned for the future. The LLWR is expected to cease operations in ~2130. It is expected that the entire facility will be closed with an engineered cap.

L.2.38. The LLWR has an environmental permit for the disposal of radioactive waste granted by EA. The site operator also has planning permission (received in 2016) from the local waste planning authority, Cumbria County Council, to allow LLW to be stacked higher in Vault 8 and 9 (the existing vaults) and for three further vaults yet to be constructed. In accordance with requirements of both the permit and planning permission, LLWR Ltd has started a major programme of work to close and cap the north end of the legacy disposal tranches and Vault 8.

L.2.39. In 2019 the LLWR completed a significant programme to decommission five legacy semi-underground buildings (magazines) which had been used in the 1960s to store Plutonium Contaminated Materials (PCM), See the case study in Section B (paragraphs B266-272) for further information on this project.

L.2.40. The waste treatment, storage and disposal facilities at the LLWR comprise:

Grouting Facility

L.2.41. This plant receives ISO-freight containers full of solid LLW from waste consignors around the UK. The containers are in-filled with a cement grout to produce a monolithic waste form, before being disposed of in the LLWR vaults.

Trenches

L.2.42. The LLWR features a series of seven clay-lined trenches where virtually all the UK's solid LLW arising between the 1950s and 1988 were disposed of by tumble-tipping in a manner similar to conventional landfill. The trenches are now full to capacity and have been temporarily capped to minimise water entry. A project to install the final, multi-layer cap has now commenced and is in the design stage.

Vaults 8 and 9

L.2.43. Since 1988 the LLW consigned to the LLWR has been placed into concrete-lined surface-level engineered vaults that accept grouted ISO-freight containers laden with conditioned LLW. Both Vault 8 and Vault 9 are permitted for disposal. Historically some ad-hoc large waste items, such as redundant fuel transport flasks, were placed in Vault 8 and grouted in situ. The programme to close and cap Vault 8 has commenced and is in the design stage.

PCM Assay Facility

L.2.44. This facility receives drums containing PCM waste for assay purposes and is used to store the waste drums prior to their transfer to Sellafield for long-term storage.

Magnox Ltd's Nuclear sites

L.2.45. Across the Magnox Ltd. sites the principal radioactive waste storage facilities are:

- underground vaults;
- above-ground vaults;
- reactor voids;
- tanks; and
- packaged ILW storage facilities.

L.2.46. No two sites are the same; however common approaches and technologies are applied where possible to optimise waste management.

L.2.47. For ILW, specific container-and-conditioning approaches are used to produce waste packages that are suitable for long-term management (and disposal in the GDF, where applicable). The approaches currently used by Magnox Ltd. include:

- Stainless steel containers for use with grouting technology to create an encapsulated waste-form.
- DCICs for use with vacuum drying technology (where the waste requires drying) to create a dry, non-encapsulated waste-form.
- Concrete containers (concrete boxes), for use with grouting technology to create an encapsulated waste-form.

L.2.48. There are variations of conditioning facilities that have been / are being used. The commonly used ones are:

- The advanced vacuum drying system (AVDS) or ambient temperature conditioning system (ATCS) which reduces the pressure within a DCIC to evaporate water at low temperatures. The AVDS applies heating to the DCIC to increase the rate of evaporation, whereas the ATCS does not.
- The modular intermediate level waste encapsulation plant (MILWEP) which will be used at several sites in conjunction with the concrete box. This replicable design builds on experience of operating plant-specific encapsulation facilities with other containers at sites such as Hunterston A and Trawsfynydd.

L.2.49. ILW interim storage facilities also exist at various sites, some of bespoke design and several using a common, scalable design.

L.2.50. Table 12 shows which of the principal ILW management approaches are used, or are currently planned to be used, at each Magnox Ltd. site.

Table 12: Approaches used for the management of ILW at Magnox Ltd sites

Site	ILW Containers	Encapsulation Facility	Vacuum Drying Plant	Interim ILW Store
Berkeley	DCICs Concrete boxes	Yes	Yes	Yes

Site	ILW Containers	Encapsulation Facility	Vacuum Drying Plant	Interim ILW Store
Bradwell	DCICs	No	Yes	Yes
Chapelcross	DCICs Concrete boxes	Yes	Yes	Yes
Dungeness A	DCICs	No	Yes	No – transported to Bradwell store
Harwell	Stainless steel Concrete boxes	Yes	No	Yes
Hinkley Point A	DCICs Concrete boxes Stainless steel	Yes	Yes	Yes
Hunterston A	Stainless steel	Yes	No	Yes
Oldbury	DCICs	No	Yes	No – transported to Berkeley store
Sizewell A	DCICs	No	Yes	No – transported to Bradwell store
Trawsfynydd	Stainless steel	Yes	No	Yes
Winfrith	Concrete boxes	Yes	No	No – transported to Harwell store
Wylfa	DCICs	No	Yes	Yes

L.2.51. Each Magnox Ltd. site has a bespoke management facility capable of processing the site's LLW and preparing for onwards management via the most appropriate route, which may include treatment enabling management as out-of-scope.

L.2.52. Facilities, of varying designs, used to treat radioactive liquid effluent, such as that arising from the fuel storage ponds, exist/existed at each Magnox Ltd. site. To enable these facilities to be decommissioned, Magnox Ltd. has developed a generic MAETP design which has the capability to abate both particulate and soluble radionuclides, and be tailored to meet the requirements of each site through selection of the appropriate modules. To date, the MAETP has been installed at Dungeness A and Hinkley Point A and is due for installation at Chapelcross during 2020.

Tradebe Inutec Ltd

L.2.53. Tradebe Inutec currently operates a complex of facilities dedicated to the management of radioactive wastes from a broad selection of UK nuclear sites. Tradebe Inutec became a licensee in its own right in February 2019 when it was granted a nuclear site licence by ONR. It was previously a tenant on the Magnox Ltd Winfrith site in Dorset, southern England. Amongst other specialist waste management services, through LLWR Ltd's commercial frameworks, Tradebe Inutec offers super-compaction, sort & segregation services and treatment of contaminated metals. The latter service includes access to a smelter at Siempelkamp in Germany or to a smelter in the USA via transfrontier shipments.

Dounreay

L.2.54. The main facilities for the management of radioactive waste at Dounreay comprise:

Dounreay Cementation Plant for Immobilisation of ILW Liquors

L.2.55. This plant processes liquid wastes that arose from reprocessing of Materials Test Reactor fuel, DFR and PFR fuels. The liquors are transferred from storage tanks and immobilised in a cementitious matrix within 500L drums for long-term interim storage and future disposal. Immobilisation of the MTR and DFR liquid waste has been completed and the plant has been modified and actively commissioned to demonstrate immobilisation of PFR liquid waste. The remaining liquid will be cemented once an additional waste store has completed its construction and commissioning stages.

Dounreay Wet Silo

L.2.56. The wet silo is an engineered store that contains long-lived solid ILW, stored under water together with the sludge resulting from operations and material degradation. The wet silo closed for the receipt of solid waste in 1998. Plans are being developed to retrieve the solid waste and sludge waste for processing for long-term interim storage.

Dounreay Shaft

L.2.57. The 65m-deep Dounreay shaft was originally excavated in order to remove spoil during the construction of a sub-sea effluent discharge tunnel. It was subsequently used for the disposal of solid ILW arising from historical fuel-cycle operations during the period 1959 to 1977. The shaft has been isolated by a grout curtain to minimise the ingress of groundwater, in preparation for the retrieval of solid waste for encapsulation and the sludge waste for processing for long-term interim storage.

Low-Level Liquid Effluent Treatment Plant

L.2.58. This plant consists of an underground effluent receipt tank, buffer tank, two main effluent holding tanks and final filtration equipment. The main purpose of the plant is to adjust the pH of incoming low-active effluent and to settle the resulting sludge before discharging the effluent to sea. The settled sludge is periodically removed and encapsulated in 200L drums and managed through the site's standard LLW processes.

Low-Level Waste Receipt Assay and Characterisation and Super-compaction Facility

L.2.59. This facility undertakes the assay and volume reduction of 200L drums of solid LLW. After super-compaction, the compacted drum pucks are loaded into half-height ISO containers for subsequent storage and disposal.

Store for Unconditioned Solid Remote-Handled ILW 200L Drums

L.2.60. This facility stores accumulations of solid remote-handled ILW. This waste is being progressively transferred to the combined conditioned ILW 500L drum store and raw solid remote-handled ILW 200L drum store. Once all the waste has been treated and transferred, this store will be decommissioned.

Store for Unconditioned Solid Contact-Handled ILW 200L Drums

L.2.61. This facility is currently used for storing accumulations of PCM, uranium-contaminated waste and thorium-contaminated waste, collectively known as contact-handled ILW.

Store for Conditioned ILW 500L Drums and Raw Solid Remote Handleable Intermediate Level Waste (RHILW) 200L Drums

L.2.62. This facility is used to store drums containing immobilised liquors that arose from reprocessing spent fuel from Dounreay reactors (MTR, DFR and PFR) and other solid remote-handleable ILW.

Liquid ILW Storage Facility

L.2.63. This facility provided tank storage for liquors from reprocessing of spent fuels from the Material Test Reactor, DFR and Prototype Fast Reactor. Only Liquors from PFR and tank washings remain to be conditioned through the cement plant.

Solvents and Oil Storage Facility

L.2.64. This facility included tanks holding ILW-contaminated solvent resulting from PFR fuel reprocessing, and bulk storage containers for low-level contaminated oils. Most of these oils and solvents have been transferred to third parties for treatment. Work is underway to complete this process to allow the facility to be decommissioned.

Dounreay LLW Disposal Facility

L.2.65. A facility on the Dounreay licensed site for the disposal of solid LLW was closed in 2005. LLW accumulated at Dounreay between 2005 and 2015 were placed in interim storage on the site.

L.2.66. In 2013, SEPA issued a disposal authorisation for a new near-surface disposal facility for solid LLW, adjacent to the existing licensed nuclear site boundary. The new facility received its first conditioned LLW for disposal in 2015. LLW from the Dounreay and neighbouring Vulcan defence site are conditioned and accepted for disposal. At present two disposal vaults have been built. Planning permission is available for a further 4 vaults which may be built as the sites' decommissioning programmes progress.

EDF Nuclear Generation Limited

L.2.67. The EDF(NG) power stations feature the following principal radioactive waste facilities:

- Each site has a range of facilities for processing and storing a range of LLW and other wastes;
- Vaults/voids/drum stores – used for storage of high dose rate material, including redundant reactor and fuel assembly components;
- Wet waste storage tanks – either stainless steel or lined concrete cells used to store spent resins and sludge;
- DCICs used at Sizewell B to store ILW spent ion exchange resins;
- Desiccant storage – provided by vaults at two AGR nuclear power stations and in-drum storage on other sites.

L.2.68. The wastes on EDF(NG) sites are of the following general types:

- AGR fuel stringer debris – a product from dismantling of spent fuel assemblies prior to dispatch of elements to Sellafield. These wastes are almost all metallic and are stored in the integral voids described above;
- Other dry wastes – miscellaneous contaminated or activated components. These are significantly less radioactive than fuel stringer debris, but are still likely to remain ILW for many decades;
- Spent resins and sludge – ion exchange resins and sand filters (for particulates) are used to manage the quality of water in fuel storage ponds. At Sizewell B resin is more extensively used than on the AGRs, due to the need to keep the primary circuit coolant water within tight chemical limits;
- Water system cartridge filters – at Sizewell B, filters are generated as waste from operational control of water quality in a range of systems. The characteristics of the filters range from ILW to potential free release. They are stored in ILW/LLW drum stores, as appropriate;
- Desiccants – used to minimise moisture within the primary circuits of AGRs. A process has been used to treat desiccants to remove their principal contaminant (tritium) at Winfrith, following which they are encapsulated and disposed of to the LLWR. A process to wash desiccant to remove tritium and make it suitable for disposal by incineration is being considered. This would reduce disposals to the LLWR.

GE Healthcare

L.2.69. GE Healthcare Ltd. (GEHC) used to produce isotopes for use in medical diagnostics and scientific research.

L.2.70. The company previously managed three licensed nuclear sites in the UK, but ceased operations on its section of the Harwell site, decommissioned its facilities there and surrendered its site licence in 2012. The vacated plot is now encompassed by Magnox Ltd’s nuclear site licence – GEHC has no remaining nuclear liabilities on the Harwell site.

L.2.71. The Grove Centre site (near Amersham, South-East England) has a long history of handling radioactive materials in numerous facilities since around 1940. The site manufactured radiopharmaceutical products for many years, but throughput reduced significantly and in 2018 GEHC ceased production and stated its intent to decommission and clean up the site for its re-use. The facilities at the Grove Centre are being progressively decommissioned, with resultant ILW placed within a purpose-built on-site store mainly inside 500L stainless steel drums. The store has sufficient capacity for all anticipated operational and decommissioning wastes. The site is implementing a decommissioning plan that will result in further generation of ILW for on-site storage pending ultimate disposal options. The clean-up of contaminated land has been a challenge for GEHC but building on its experience at its Cardiff site the work is progressing to the point that it would be able to be de-licensed in the next few years.

L.2.72. GEHC’s Maynard Centre near Cardiff (Wales) completed its final site clean-up and demonstrated to ONR that its site presented no danger from ionising radiation which enabled ONR in December 2019 to revoke the site licence and end GEHC’s period of responsibility. The site will now be re-used for other purposes.

Cyclife Metal Recycling Facility (MRF)

L.2.73. The MRF was first brought into operation in September 2009. All licensed nuclear sites in England and Wales are able to consign metallic waste for recycling to the MRF. Sites in Scotland can also apply to SEPA for an authorisation to have their metallic wastes treated at the MRF. The purpose of the facility is to reduce the volumes of metallic waste for disposal at the LLWR, while recovering valuable uncontaminated metal for recycling. The site processes low-level radioactive metals using a range of techniques such as size reduction and shot blasting. Cyclife UK can also co-ordinate trans-frontier shipment of radioactive metallic wastes to facilities in Sweden for treatment by melting.

National Nuclear Laboratory

L.2.74. NNL provides services covering the complete nuclear fuel cycle from fuel manufacture and power generation, through reprocessing and waste treatment to disposal. It includes defence, new nuclear build and security, supported by a range of links with international research organisations, academia and other national laboratories. It has laboratory facilities at Sellafield, Windscale, Springfields and Workington, together with office locations elsewhere.

L.2.75. NNL's role was clarified and restated in the UK government's Nuclear Industrial Strategy in March 2013, with NNL's work to support the UK's decommissioning programme alongside electricity generation from existing nuclear power stations. NNL is a government-owned, government-operated organisation (GoGo).

L.2.76. In relation to the future development of nuclear energy, the government announced a £250 million programme of research in 2015, with a key element being focussed on the development of Small Modular Reactors (SMRs). Other key areas to be funded – in line with the recommendations of the Nuclear Innovation and Research Advisory Board – include nuclear fuels; advanced nuclear manufacturing; reactor design; and recycling technology. NNL has a science and technology strategy that focuses on key research areas (including those listed), which are important for the organisation's future growth, and that provides a focus for the maintenance and development of critical nuclear skills, which is a government objective.

Springfields Fuels Limited (SFL)

L.2.77. The Springfields site has manufactured a range of nuclear fuel products for both UK and international customers since the late 1940s.

L.2.78. SFL has an ongoing programme of decommissioning redundant uranium processing facilities across the site. Large areas of the site have been cleared to below ground level and remediated where necessary, potentially for reuse. Over many years SFL has decommissioned and safely dismantled a significant number of facilities, which dated back to the start of nuclear operations.

L.2.79. From April 2010, the NDA permanently transferred ownership of the assets and liabilities of the company to Westinghouse Electric under the terms of a 150 year lease; in 2018 SFL was sold as part of Toshiba's sale of Westinghouse to Brookfield, a Canadian company. NDA retains ownership of the site's freehold and the liabilities contained on a small enclave on the licensed nuclear site.

L.2.80. SFL is contracted to provide decommissioning and clean-up services to the NDA to address historic liabilities.

Capenhurst works

L.2.81. Urenco UK Ltd (UUK) owns and operates the Capenhurst site principally to enrich uranium for civil nuclear fuel manufacturing purposes. One of the main nuclear hazards on the site is associated with the storage of depleted uranium hexafluoride (called “Hex Tails”), The “Hex Tails” have arisen from years of enrichment plant operations; the site’s overall inventory is currently limited. This has led to the licensee deciding to de-convert this material into a safer more chemically stable form of uranium oxide powder. A Urenco owned tenant on the site, Urenco Chemical Plants (UCP), will undertake the de-conversion in its new TMF (see Section B paragraphs B44 to B49).

L.2.82. Urenco has established Urenco Nuclear Stewardship (UNS), which is a tenant on the Urenco site, to provide responsible management of uranic materials and carry out remediation work on behalf of the NDA. UNS manages 95% of the NDA’s uranic inventory and provides broader decommissioning and remediation works for redundant facilities.

L.2.83. The NDA owned and managed uranic inventory includes a substantial “Hex Tails” legacy. This is currently, being stored in transport containers, some fifty or more years old, on part of the site controlled by UNS. This legacy material will be decanted into new containers for interim storage, before it is eventually processed through the TMF.

Decommissioning Facilities

Article 32.2: This report shall also include:

v) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.

L.2.84. A list of the main UK nuclear facilities that are in the process of being decommissioned, and the status of decommissioning activities at those facilities, is summarised below.

Sellafield

Table 13: Decommissioning facilities at Sellafield

Facility	Date of Closure	State of Decommissioning
First reprocessing plant	1973	In progress.
Solvent purification plant	1973	Plant and equipment removed.
Analytical facilities	c.1960s	Plant and equipment being removed from redundant laboratories.
Pilot reprocessing plant	1980s	Removed.
Fast reactor fuel plant	1988	Most plant and equipment removed.
MOX fuel demonstration plant	2003	In progress.
Calder Hall nuclear power station	2003	Reactors defueled in 2019.
Solid waste store	c.1970s	Material being recovered and repacked for modern stores.

Plutonium purification plants (several)	Various	Most plant and equipment removed, some buildings removed. Removal of a contaminated ventilation ducting is progressing.
Uranium purification plant.	1990s	Plant, equipment and building removed.
Floc Storage tanks	1994	Flocs arising from liquid effluent treatment are being retrieved, encapsulated and placed in HAW stores.
Magnox sludge settling facility	1984	Sludge removed, plant and equipment being removed.
Pile Fuel Storage Pond (PFSP)	1960	The nuclear fuel has been removed and is now stored in modern engineered storage facilities. Pond sludge is being retrieved and encapsulated in the Waste Encapsulation Plant.
Pile Fuel Cladding Silo (PFCS)	1967	Retrievals equipment to remove waste from the silos has been developed and commissioned. Waste retrievals will commence later in 2020 or 2021.
First Generation Magnox Storage Pond (FGMSP)	1990	The transfer of sludge to sludge buffer tanks continues. Since fuel exports began in 2016 nearly a quarter of the fuel has been removed.
Magnox Sludge Storage Silo (MSSS)	1990	Some swarf was retrieved and encapsulated in the 1990s. Successful transfers of silo liquor are now routine and are transferring soluble mobile inventory to the SIXEP plant for capture on ion-exchange media.
Windscale Advanced Gas cooled Reactor (WAGR)	1981	Reactor has been decommissioned. Only the bioshield, the external clad sphere and some ancillary plant remain.
Windscale Piles air-cooled graphite reactor (including chimneys)	1957	Reactors have been defueled with the exception of the fire affected zone of Pile 1 (which suffered a fire in 1957). Plant supporting the reactors has been removed or disconnected. The demolition of the remaining ventilation chimney for Pile 1 has been progressing successfully.
Fuel examination facility	1995	Facility is moving into surveillance and maintenance.
Lead-shielded cells, used for PIE of fuel	Part operational	Facility is currently in surveillance and maintenance.

Magnox Ltd's nuclear sites

L.2.85. The Magnox power stations have all been fully defueled and are in various stages of decommissioning (Table 14). The Bradwell site is now in an extended period of Care and Maintenance. The decommissioning strategy for other sites is site specific, including entry into an extended period of C&M or accelerated decommissioning to an agreed end-state. As described above, Magnox is consolidating ILW in a small number of regional ISFs.

Table 14: Decommissioning facilities on Magnox Limited nuclear sites

Station	Date of Cessation of Generation	State of Decommissioning
Berkeley	1989	• Defueled in 1992 and spent fuel transferred to Sellafield for reprocessing; • 15 boilers transferred to a Swedish LLW metal melting and recycling facility; • Fuel ponds drained, pond equipment removed and pond structure demolished; • Reactor buildings prepared for storage; • Interim ILW store is fully operational; • ILW retrieval and packaging operations underway. Imports of ILW packages from Oldbury begun.
Bradwell	2002	• Defueled in 2005 and spent fuel transferred to Sellafield for reprocessing; • Fuel ponds drained, pond stabilised and in storage; • Reactor buildings de-planting and in storage; • Interim ILW store fully operational; • ILW retrieval and packaging operations complete; • Entered into a 70 year period of C&M in November 2018. • Imports of ILW packages from Dungeness A have begun.
Chapelcross	2004	• Defueled in 2013 and spent fuel transferred to Sellafield for reprocessing; • Fuel pond 1 drained and stabilised, work underway on Pond 2; • Cooling towers demolished; • Construction of interim ILW store complete; • ILW retrieval and packaging operations are underway.
Dungeness A	2006	• Defueled in 2012 and spent fuel transferred to Sellafield for reprocessing; • Fuel ponds drained and stabilised; • ILW retrieval and packaging operations are underway. ILW packages are being transferred to the Bradwell interim store.

Station	Date of Cessation of Generation	State of Decommissioning
Harwell	n/a	• Low-energy graphite reactor – fully decommissioned. Graphite core incinerated at an off-site facility; • Experimental graphite reactor, materials testing reactors and PIE concrete-shielded cells all in storage; • ILW retrieval and packaging operations are underway; • Nuclear materials are being transferred off-site.
Hinkley Point A	2000	• Defueled in 2004 and spent fuel transferred to Sellafield for reprocessing; • Fuel ponds drained and stabilised; • Interim ILW store is under construction; • ILW retrieval and packaging operations are underway.
Hunterston A	1990	• Defueled in 1995 and spent fuel transferred to Sellafield for reprocessing; • Fuel ponds drained and stabilised; • Interim ILW store is fully operational; • ILW retrieval and packaging operations are underway.
Oldbury	2012	• Defueled in 2016 and spent fuel transferred to Sellafield for reprocessing; • Fuel ponds drained and stabilised; • ILW retrieval and packaging operations are underway. ILW packages are being transferred to the Berkeley interim store.
Sizewell A	2006	• Defueled in in 2014 and spent fuel transferred to Sellafield for reprocessing; • Fuel ponds drained and stabilised; • ILW retrieval and packaging operations are at the design stage. ILW packages will be transferred to the Bradwell interim store;
Trawsfynydd	1993	• Defueled in 1996 and spent fuel transferred to Sellafield for reprocessing; • Fuel ponds drained; • Interim ILW store is fully operational; • ILW retrieval and packaging operations are underway.
Winfrith	n/a	• Experimental high-temperature helium-cooled power reactor (DRAGON) and Steam-Generating Heavy Water Reactor (SGHWR) have been emptied of all fuel and are being decommissioned; • Zero energy reactor to support fast reactor core physics (ZEBRA) and PIE facility are fully decommissioned; • ILW retrieval and packaging operations are being prepared for. ILW packages will be transferred to the Harwell interim

Station	Date of Cessation of Generation	State of Decommissioning
		stores.
Wylfa	2015	• Defueled in 2019 and spent fuel sent to Sellafield for reprocessing; • ILW retrieval and packaging operations are at the design stage.

Dounreay

Table 15: Decommissioning facilities at Dounreay

Facility	Date of Closure	State of Decommissioning
Materials Test Reactor (MTR)	1969	Final demolition is underway.
Dounreay Fast Breeder Reactor (DFR)	1977	Destruction of the bulk liquid metal coolant from the primary circuit was completed in 2012. Development is continuing of techniques for removal of sodium potassium residues from the internal surfaces of the reactor and associated equipment, which includes~ 10km of cooling pipework. The Breeder Fuel Removal facility is operational and has removed more than 50% of the breeder fuel elements from the reactor.
Prototype Fast Reactor	1994	Stage 1 decommissioning is in progress. The bulk sodium from the core, secondary circuits and irradiated fuel cell has been removed and destroyed. The secondary circuits have completed Stage 3 decommissioning. Plant design for removal of residual sodium from the internal surfaces of the reactor and associated equipment is underway.
Range of analytical and metallurgical laboratories and fuel examination facilities	Part operational	Decommissioning of the fume cupboard and glove-boxes and some shielded labs has been completed. Decommissioning of the remaining shielded labs will commence at the cessation of operations in 2022 once the need for high active sample analysis is removed.
Facility for handling and examination of irradiated fuel	2006	Stage 2 decommissioning completed on the redundant cells and currently progressing through Stage 3 decommissioning
Post-irradiated examination (PIE) facility	1993	Stage 2 decommissioning completed on redundant cells and now prepared for commencement of Stage 3 decommissioning, with the removal of the shielded cell structures.
Criticality experiment suite and Plutonium-handling building	1963	Decommissioned and demolished.
Shaft and Silo disused ILW storage facilities	1977 and 1999 respectively	The shaft has been hydraulically isolated from surrounding bedrock by cementitious grouting via a matrix of injection boreholes. Design work being progressed on the retrieval facility. Waste will be retrieved from the ILW Shaft and Silo at the earliest practicable date and the waste conditioned for storage.
Plants for the development of	2001	Stage 1 decommissioniong underway.

reprocessing of mixed-oxide fuels, and associated facilities		
Fast Reactor Fuel reprocessing plant	1998	Stage 1 decommissioning completed and currently undergoing Stage 2 decommissioning. Includes the Pu evaporator and export facility.
MTR fuel fabrication facility	2005	Facility decommissioned and demolished.
Enriched Uranium processing facility	2006	Redundant areas have completed Stage 2 decommissioning. Stage 1 decommissioning of the remaining plant has commenced.
LLW treatment plant	2004	Decommissioned and demolished.

Low-Level Waste Repository

Table 16: Decommissioning facilities at the LLWR

Facility	Date of Closure	State of Decommissioning
Magazine 3, 4, 5, 9, 10	2007	All decontamination, decommissioning and clean-up activities complete. Demolition is pending.

Spent Fuel Inventory

Article 32.2: This report shall also include:

ii) an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity;

L.2.86. The UK's current stock of spent fuel as of 1 April 2019 consists mainly of Magnox, AGR and PWR fuels, but also includes small stocks of various spent experimental fuels. Spent fuels designated as a waste are reported alongside other waste streams in the UK RWI. Notably, this includes GLEEP fuel, Dragon fuel and Zenith fuel, small quantities of irradiated thorium and PFR mixed breeder sections. As a result, these spent fuels are not included within the figures stated in this report, which account for those fuels not yet designated as a waste. No spent fuel has been disposed of in the UK to date.

L.2.87. A summary of the inventory is provided below in Table 17 [27].

Table 17: UK-owned irradiated fuel (mass in stocks 1 April 2019 and estimated future arisings)

Location	Description	Stock at 1 April 2019 (1)		Estimated Future Arising
		In Reactor (teHM)	In Storage (teHM)	
Sellafield	Magnox fuel	- (2)	625	- (3)
	AGR fuel	-	~2050	- (4)
	SGHWR fuel	-	68	-

Location	Description	Stock at 1 April 2019 [1]		Estimated Future Arising
	WAGR fuel	-	21	-
	Other fuels [5]	-	~790	-
Dounreay	DFR breeder fuel	~21	~3	-
	PFR	-	10	-
	Other fuels	-	~1	-
Magnox power stations [6]	Magnox fuel	149 [9]	73	-
AGR power stations	AGR fuel [7]	~1,500	~150	~1800
PWR power station	PWR fuel [7]	~90	~530	~430
Others	Various		~1 [8]	-
Total		**~1800**	**~4,300**	**~2,200**

(1) Fuel 'In reactor' is that in reactor cores; fuel 'In storage' has been removed from reactor cores to storage facilities.

(2) Fuel at Calder Hall is included under 'Magnox power stations'.

(3) See Magnox power stations for future transfers of spent fuel to Sellafield.

(4) See AGR power stations for future transfers of spent fuel to Sellafield.

(5) Includes various legacy uranium metal and oxide fuels, former overseas LWR fuel transferred to UK ownership and DFR breeder fuel transferred from Dounreay.

(6) Includes Calder Hall on the Sellafield site.

(7) From data provided by EDF(NG) and from best available public domain information.

(8) Comprises low irradiated fuels at Harwell.

(9) As of late 2019, all Magnox reactors are fully defueled

Radioactive Waste Inventory

Article 32.2: This report shall also include:

iv) an inventory of radioactive waste that is subject to this Convention that:

(a) is being held in storage at radioactive waste management and nuclear fuel cycle facilities;

(b) has been disposed of; or

(c) has resulted from past practices.

This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides;

L.2.88. A summary of the UK's radioactive waste inventory is provided in Table 18 to Table 20: Total wastes in Stock on 1 April 2019 and estimated future waste arising below. Further more detailed information on the UK's inventory is made publicly available on the NDA website at UKRWI [27].

Table 18: Radioactive wastes from all sources stock at 1 April 2019

Waste Type	At 1 April 2019	Reported Volume (m^3)(1)	Reported Mass (tonne)(1)	Packaged Volume (m^3)	Number of Packages(4)
HLW	Total	2,150	4,000	-	-
	Not yet packaged	1240	1,600	-	-
	Already packaged	915	2,400	1,200	6,101
ILW	Total	102,000	130,000	-	-
	Not yet packaged(2)	66,900	61,000	-	-
	Already packaged	35,100	66,000	46,300	67,307
LLW	Total	27,400(3)	38,000	-	-
	Not yet packaged	22,700	28,000	-	-
	Already packaged	4,640	10,000	6,990	1,324
VLLW	Total	1,040	920	-	-
	Not yet packaged	1,040	920	-	-
	Already packaged	0	0	-	-

(1) Volume and mass “not yet packaged” are for untreated or partly treated waste; volume and mass “already packaged” are the conditioned volume and corresponding mass for wastes that have been encapsulated in a cement-based material, polymer or glass (i.e. waste streams with a /C in the identifier).

(2) ILW “not yet packaged” includes 1,490 m^3 reported volume that is expected to be disposed of as LLW.

(3) Includes 30 m^3 reported volume of mixed VLLW/LLW at Springfields works.

(4) ILW package numbers include 1,938 of 1803-type mild steel drums. These drums are expected to be over packed in larger capacity boxes (6 drums per box). LLW package numbers exclude those in short-term storage before consignment.

Table 19: Estimated future arising of radioactive waste

Waste Type	Reported Volume (m^3)	Reported Mass (tonne)	Packaged Volume (m^3)	Number of Packages
HLW(1)	See Note 2	See Note 2	See Note 2	See Note 2
ILW(3)	145,000	150,000	335,000	149,000
LLW(4)	1,450,000	1,800,000	1,240,000	20,800
VLLW	2,830,000	2,900,000	2,690,000	0
Total	**4,425,000**	**4,850,000**	**4,265,000**	**169,800**

(1) HLW does not include waste from reprocessing overseas spent fuel that will be exported to the country of origin, and assumes substitution arrangements are implemented

(2) From 1 April 2019 there is a net decrease in the reported volume and mass of HLW because accumulated HAL is being conditioned, which reduces its volume and mass by about two-thirds, and also because vitrified HLW is being returned to overseas customers.

(3) ILW includes 7,150 m^3 reported volume of waste that is expected to become LLW as a result of decontamination or decay storage.

(4) LLW includes 248,000 m^3 reported volume of mixed VLLW/LLW at Springfields.

Table 20: Total wastes in Stock on 1 April 2019 and estimated future waste arising

Waste Category	Reported Volume (m^3)	Reported Mass (tonne)	Packaged Volume (m^3)	Number of Packages
HLW(1)	1,390	3,200	1,500	7,660
ILW	247,000	280,000	499,000	292,000
LLW	1,480,000(2)	1,900,000	1,280,000	22,300(3)
VLLW	2,830,000(4)	2,900,000	2,690,000	See Note 5
Total	**4,560,000**	**5,100,000**	**4,470,000**	**322,000**

(1) The volume and mass do not include waste from reprocessing overseas spent fuel that will be returned to its country of origin and assume substitution arrangements are implemented.

(2) LLW includes 248,000 m^3 reported volume of mixed LLW/VLLW at Springfields.

(3) Includes only those wastes packaged for disposal at the LLWR and Dounreay LLW vaults (packaged volume 447,000 m^3). Excludes LLW streams and component parts of LLW streams whose characteristics make them suitable for recycling, incineration or appropriately permitted landfill disposal.

(4) Includes 2,700,000 m^3 reported volume from facility decommissioning at Sellafield. However the current best estimate, albeit based on limited decommissioning experience, is that 70% of this material may be 'out of scope' of regulatory control.

(5) As VLLW can be disposed to appropriately permitted landfill sites no package numbers are collated for this waste category in the Inventory.

Table 21: Total annual disposal to the low-level waste repository (2009-2019)

Year(1)	Total volume (m^3)(2)	Year(1)	Total volume (m^3)(2)
2009	6,190	2015	3,320
2010	5,700	2016	3,350
2011	6,070	2017	1,810
2012	5,000	2018	1,720
2013	4,170	2019	692.5
2014	3,650		

(1) For period 1 April to 31 March.

(2) Volume is for waste and its primary containment and represents volumes of waste received with the intent for disposal.

Table 22: Total annual disposals to the Dounreay Low-Level Waste Facility (2015-2019)

Year(1)	Total volume (m^3)(2)
2015	2,046
2016	1,901
2017	644
2018	0
2019	375

Year[1]	Total volume (m^3)[2]
2020[3]	195

(1) For period 1 January to 31 December.

(2) Packaged volume made up of LLW in Grouted HHISO containers and Demolition LLW in bags

(3) Up to 31 March.

References

1. BEIS, “The United Kingdom’s Sixth National Report on Compliance with the Obligations of the Joint Convention on the Safety of Spent Fuel and Radioactive Waste Management,” October 2017. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/672640/20171020_-_UK_Sixth_National_Report_to_the_Joint_Convention.pdf.
2. UK Government, “The Environmental Permitting (England and Wales) Regulations 2016, SI 2016/1154,” 2016. [Online]. Available: http://www.legislation.gov.uk/uksi/2016/1154/contents/made.
3. Scottish Government, “The Environmental Authorisations (Scotland) Regulations 2018,” 2018. [Online]. Available: http://www.legislation.gov.uk/sdsi/2018/9780111039014/contents.
4. Northern Ireland Executive, “Radioactive Substances Act 1993 (Amendment) Regulations (Northern Ireland), SI 2011/290,” 2011. [Online]. Available: http://www.legislation.gov.uk/nisr/2011/290/contents/made.
5. UK Government, “Review of Radioactive Waste Management Policy: final conclusions, Cm 2919,” July 1995. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/829274/review-radioactive-waste-management-policy-cm2919.pdf.
6. ONR, EA, SEPA and NRW, “The management of higher activity radioctive waste on nuclear licensed sites, Joint guidance from ONR, EA, SEPA and NRW to nuclear licensees, Revision 2,” February 2015. [Online]. Available: http://www.onr.org.uk/wastemanage/waste-management-joint-guidance.pdf.
7. BEIS, “Implementing geological disposal – Working with communities. An updated framework for the long-term management of higher activity radioactive waste.,” December 2018. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766643/Implementing_Geological_Disposal_-_Working_with_Communities.pdf.
8. NDA, “The Magnox Operating Programme (MOP 9),” 2012. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/457808/The_Magnox_Operating_Programme__MOP9_.pdf.
9. NDA, “NDA Strategy 3,” March 2016. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/518669/Nuclear_Decommissioning_Authority_Strategy_effective_from_April_2016.pdf.
10. NDA, “Progress on plutonium consolidation, storage and disposition,” March 2019. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/791046/Progress_on_Plutonium.pdf.
11. NDA, “US and UK complete project to remove highly enriched uranium,” 03 May 2019.

[Online]. Available: https://www.gov.uk/government/news/us-and-uk-complete-project-to-remove-highly-enriched-uranium.

12. Welsh Government, “Welsh Government Policy on the Management and Disposal of Higher Activity Radioactive Waste,” 2015. [Online]. Available: https://gov.wales/sites/default/files/publications/2019-06/policy-on-the-management-and-disposal-of-higher-activity-radioactive-waste.pdf.

13. Welsh Government, “Geological disposal of higher activity radioactive waste: Working with communities,” 2019. [Online]. Available: https://gov.wales/sites/default/files/publications/2019-04/geological-disposal-of-higher-activity-radioactive-waste-guidance-for-communities.pdf.

14. Scottish Government, “Scotland's Higher Activity Radioactive Waste Policy,” January 2011. [Online]. Available: https://www.gov.scot/publications/scotlands-higher-activity-radioactive-waste-policy-2011/.

15. Scottish Government, ““Implementation strategy for Scotland's policy on higher activity radioctive waste”,” December 2016. [Online]. Available: https://www.gov.scot/publications/higher-activity-waste-implementation-strategy/.

16. NDA, “NDA Integrated Waste Management: Radioactive Waste Strategy,” September 2019. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831727/Radioactive_Waste_Management_Strategy_September_2019.pdf.

17. NDA, “NDA Mission Progress Report,” July 2019. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/814660/Mission_Progress_Report_July_2019.pdf.

18. Defra, DTI and the Devolved Administrations, “Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom,” March 2007. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/254393/Low_level_waste_policy.pdf.

19. DECC and devolved administrations, “UK Strategy for the Management of Solid Low-level Waste from the Nuclear Industry,” February 2016. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/497114/NI_LLW_Strategy_Final.pdf.

20. DECC, Welsh Government, Scottish Government, DOENI, “Strategy for the management of solid low level radioactive waste from the non-nuclear industry in the United Kingdom - Part 1 - Anthropogenic Radionuclides,” 12 March 2012. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48291/4616-strategy-low-level-radioactive-waste.pdf.

21. DECC, Welsh Government, DOE and The Scottish Government, “Strategy for the management of Naturally Occurring Radioactive Material (NORM) waste in the United Kingdom,” July 2014. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/335821/Final_strategy_NORM.pdf.

22. OECD Nuclear Energy Agency Steering Committee for Nuclear Energy, “Decision and

Recommendation Concerning the Application of the Paris Convention on Third Party Liability in the Field of Nuclear Energy to Nuclear Installations for the Disposal of Certain Types of Low-Level Radioactive Waste," January 2017. [Online]. Available: http://www.oecd-nea.org/cen/docs/2016/ne2016-7-final.pdf.

23. UK Government, "The Decommissioning of the UK Nuclear Industry's Facilities," 2004. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/361068/The_Decommissioning_of_the_UK_Nuclear_Industrys_Facilities.pdf.

24. ONR, "Generic Design Assessment (GDA) of new nuclear power stations," [Online]. Available: http://www.onr.org.uk/new-reactors/.

25. NDA, "The UK Radioctive Waste Inventory," [Online]. Available: https://ukinventory.nda.gov.uk/.

26. NDA, "Radioactive Wastes in the UK - Radioactive Wastes and Materials not Reported in the 2016 Waste Inventory," March 2017. [Online]. Available: https://ukinventory.nda.gov.uk/wp-content/uploads/sites/18/2014/01/2016UKRWMI-Radioactive-wastes-and-materials-not-reported-in-2016-UK-inve....pdf/.

27. NDA, "UK Radioactive Waste Inventory: 2019 inventory," April 2019. [Online]. Available: https://ukinventory.nda.gov.uk/the-2019-inventory/2019-uk-data/.

28. NDA, "Integrated Waste Management - Higher Activity Waste Strategy," May 2016. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/522435/NDA_Higher_Activity_Waste_Strategy_2016.pdf.

29. RWM, "Geological Disposal - Overview of the generic Disposal System Safety Case," December 2016. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/634857/NDA_Report_no_DSSC-101-01_-_Geological_Disposal_-_Overview_of_the_generic_Disposal_System_Safety_Case.pdf.

30. ONR and Environment Agency, "Pre-application advice and scrutiny of Radioactive Waste Management Limited: Joint regulators' assessment of the 2016 generic Disposal System Safety Case, Issue 1," November 2018. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/756205/Joint_regulators__assessment_of_the_2016_generic_Disposal_System_Safety_Case.pdf.

31. RWM, "Packaging of radioactive waste: specifications and guidance," August 2015. [Online]. Available: https://www.gov.uk/guidance/generic-waste-package-specification.

32. NDA, "Geological Disposal: An overview of the RWM disposability assessment process," April 2014. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/461500/WPS_650_03-Geological-Disposal-An-overview-of-the-RWM-Disposability-Assessment-Process.pdf.

33. ONR and SEPA, "Inspection of RWM's disposability assessment process for the management of HAW in Scotland: A joint report by the Office for Nuclear Regulation and the Scottish Environment Protection Agency," September 2017. [Online]. Available:

https://www.sepa.org.uk/media/328612/inspection-of-rwm-s-disposability-assessment-process-for-the-management-of-haw-in-scotland.pdf.

34. NDA, “Industry Guidance on the Interim Storage of Higher Activity Waste Packages - Integrated Approach, Issue 3,” January 2017. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/600642/Industry_Guidance_-_Interim_Storage_-_Intetgrated_Approach.pdf.

35. SEPA, EA and NRW, “Management of radioactive waste from decommissioning of nuclear sites: Guidance on Requirements for Release from Radioactive Substances Regulation,” July 2018. [Online]. Available: https://www.sepa.org.uk/media/365893/2018-07-17-grr-publication-v1-0.pdf.

36. NDA, “ENG01 - Specification and Guidance on the Content and Format of an Integrated Waste Strategy,” October 2012. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/517827/ENG01-Specification-and-Guidance-on-the-Content-and-Format-of-an-Integrated-Waste-Strategy.pdf.

37. LLWR Ltd, “National Waste Programme Blueprint (NWP/ REP/045), Issue 4,” January 2018. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/697044/NWP_Blueprint_Issue_4_2018_final.pdf.

38. LLWR, “LLWR Waste Matric Dashboard,” March 2020. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879449/Waste-Metric-Dashboard-March-2020_Issue_1.pdf.

39. ONR, “Quarterly Statement of Civil Incidents reported to ONR - 01 October 2019 - 31 December 2019,” [Online]. Available: http://www.onr.org.uk/quarterly-stat/2019-4.htm.

40. NDA, “Information Governance Strategy,” February 2013. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/452203/NDA_Information_Governance_Strategy_February_2013.pdf.

41. BEIS, “UK Industrial Strategy: Building a Britain fit for the future,” 2017. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf.

42. BEIS, “Industrial Strategy: Nuclear Sector Deal,” 2018. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/720405/Final_Version_BEIS_Nuclear_SD.PDF.

43. BEIS, “Funding for nuclear innovation,” November 2016. [Online]. Available: https://www.gov.uk/guidance/funding-for-nuclear-innovation.

44. ONR, “Holding industry to account and influencing improvement – A guide to enabling regulation in practice,” February 2018. [Online]. Available: http://www.onr.org.uk/documents/2018/guide-to-enabling-regulation-in-practice.pdf.

45. Environment Agency, “Regulating for people, the environment and growtih, 2018,” October 2019. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_d

ata/file/865277/Regulating_for_people_the_environment_and_growth_2018.pdf.

46. TotalDECOM, “Report of a Cross-Sector Round Table Discussion: Innovation and Regulation,” May 2019. [Online]. Available: https://www.totaldecom.com/news/cross-industry-decommissioning-innovation-regulationworkshop/.

47. TWI, “Nuclear Decommissioning at Sellafield using LaserSnake,” 2020. [Online]. Available: https://www.twi-global.com/media-and-events/insights/laser-cutting-for-nuclear-decommissioning-at-sellafield.

48. NDA, “Decommissioning drones take to the sky,” January 2020. [Online]. Available: https://www.gov.uk/government/case-studies/decommissioning-drones-take-to-the-sky.

49. NDA, “Dounreay switches to drones,” November 2017. [Online]. Available: https://www.gov.uk/government/news/dounreay-switches-to-drones.

50. NDA, “Decommissioning learnings: Sharing good practice across industrial sectors,” [Online]. Available: www.world-nuclear-news.org/Articles/Industries-can-share-lessons-from-decommissioning.

51. Civil Service, “Introduction to Devolution,” [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770300/IntroductionToDevolution.pdf.

52. ONR, “Licensing Nuclear Installations,” September 2019. [Online]. Available: http://www.onr.org.uk/licensing-nuclear-installations.pdf.

53. ONR, “Licence condition handbook,” February 2017. [Online]. Available: http://www.onr.org.uk/documents/licence-condition-handbook.pdf.

54. ONR, “Safety Assessment Principles for Nuclear Facilities, 2014 Edition, Revision 1,” January 2020. [Online]. Available: http://www.onr.org.uk/saps/saps2014.pdf.

55. ONR, “Technical assessment guides,” [Online]. Available: http://www.onr.org.uk/operational/tech_asst_guides/index.htm.

56. BEIS, “Regulators’ Code,” April 2014. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/300126/14-705-regulators-code.pdf.

57. Environment Agency, Scottish Environment Protection Agency & Northern Ireland Environment Agency, “Near-surface Disposal Facilities on Land for Solid Radioactive Wastes - Guidance on Requirements for Authorisation, GEH00209BBJL-E-E,” February 2009. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296507/geho0209bpjl-e-e.pdf.

58. UK Government, “Health and Safety at Work etc. Act 1974, SI 1974/37,” 1974. [Online]. Available: http://www.legislation.gov.uk/ukpga/1974/37/contents.

59. UK Government, “Nuclear Installations Act 1965, SI 1965/57,” 1965. [Online]. Available: http://www.legislation.gov.uk/ukpga/1965/57/contents.

60. UK Government, “The Nuclear Installations Regulations 1971 SI 1971/381,” 1971. [Online].

Available: http://www.legislation.gov.uk/uksi/1971/381/contents/made.

61. ONR, “Implementing ONR’s strategy for licensing a future Geological Disposal Facility: Review of ONR’s regulatory guidance for Geological Disposal,” 31 March 2017. [Online]. Available: http://www.onr.org.uk/pars/2018/non-site-specific-16-032.pdf.
62. UK Government, “The Nuclear Reactors (Environmental Impact Assessment for Decommissioning) (Amendment) Regulations 2018 SI 2018/834,” 2018. [Online]. Available: http://www.legislation.gov.uk/uksi/2018/834/contents/made.
63. ONR, “Agency Agreements, Memoranda of Understanding (MoUs) and working arrangements protocol,” [Online]. Available: http://www.onr.org.uk/agency-agreements-mou.htm.
64. UK Government, “Legislative and Regulatory Reform Act 2006,” 2006. [Online]. Available: http://www.legislation.gov.uk/ukpga/2006/51/contents.
65. Crown Prosecution Service, “The Code for Crown Prosecutors,” October 2018. [Online]. Available: https://www.cps.gov.uk/publication/code-crown-prosecutors.
66. ONR, “Technical Assessment Guide on Licensee core safety and intelligent customer capabilities, NS-TAST-GD-049 Revision 6,” April 2019. [Online]. Available: http://www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-049.pdf.
67. Nuclear Energy Skills Alliance, “Nuclear Workforce Assessment 2015, Rev.1,” November 2015. [Online]. Available: https://www.nssguk.com/media/1323/publications-nuclear-workforce-assessment-2015_r1.pdf.
68. Nuclear Skills Strategy Group , “Skills planning to drive sector productivity - Strategic plan update, Winter 2018,” 2018. [Online]. Available: https://www.nssguk.com/media/1472/nssg-strategic-plan-update-2018.pdf.
69. Nuclear Skills Strategy Group, “NSSG: Equality, Diversity and Inclusion (ED&I) in the Nuclear Sector: An ED&I strategy,” [Online]. Available: https://www.nssguk.com/media/1757/edi-strategy-final.pdf.
70. UK Government, “Energy Act 2004, 2004/20,” 2004. [Online]. Available: https://www.legislation.gov.uk/ukpga/2004/20/contents.
71. NDA, “People Strategy,” August 2010. [Online]. Available: https://tools.nda.gov.uk/publication/people-strategy-august-2010/.
72. National Skills Academy Nuclear, “National Skills Academy Nuclear,” [Online]. Available: https://www.nsan.co.uk/.
73. Nuclear Gateway, [Online]. Available: www.nucleargateway.co.uk.
74. National Nuclear Laboratory , [Online]. Available: https://www.nnl.co.uk/.
75. National College for Nuclear, [Online]. Available: https://www.ncfn.ac.uk/.
76. The Nuclear Institute, “Women in Nuclear UK,” [Online]. Available: https://www.nuclearinst.com/Women-in-Nuclear-UK.
77. Nuclear Skills Strategy Group, “Nuclear sector gender roadmap: A journey to a diverse and inclusive sector,” 2017. [Online]. Available: https://www.nssguk.com/media/2017/nssg-win-

sector-gender-roadmap_web.pdf.

78. Nuclear Technology Education Consortium, [Online]. Available: http://www.ntec.ac.uk/.

79. DISTINCTIVE University Consortium, [Online]. Available: http://distinctiveconsortium.org/.

80. nucleargraduates, [Online]. Available: www.nucleargraduates.com.

81. Nuclear Skills Strategy Group, "Nuclear Career Pathways," [Online]. Available: https://www.nssguk.com/nuclear-career-pathways/.

82. Nuclear Skills Strategy Group, "Hinkley Point C Project has created 529 apprenticeships and aspires is to create 1,000 more," February 2020. [Online]. Available: https://www.nssguk.com/news/news/hinkley-point-c-project-has-created-529-apprenticeships-and-our-aspiration-is-to-create-1-000/.

83. Nuclear Skills Strategy Group, "Nuclear Workforce Assessment 2019: A scenario based approach to nuclear workforce planning," November 2019. [Online]. Available: https://www.nssguk.com/media/2018/nuclear-workforce-assessment-2019-full-report-final.pdf.

84. UK Government, "Energy Act 2008, SI 2008/32," 2008. [Online]. Available: http://www.legislation.gov.uk/ukpga/2008/32/contents.

85. UK Government, "The Ionising Radiations Regulations 2017, SI 2017/1075," 2017. [Online]. Available: http://www.legislation.gov.uk/uksi/2017/1075/contents/made.

86. Northern Ireland Executive, "Ionising Radiations Regulations (Northern Ireland) 2017, SI 2017/229," 2017. [Online]. Available: http://www.legislation.gov.uk/nisr/2017/229/made.

87. HSE, "Ionising Radiations Regulations 2017 Approved Code of Practice and guidance," 2018. [Online]. Available: https://www.hse.gov.uk/pUbns/priced/l121.pdf.

88. EA, SEPA, NRW, NIEA and FSA, "Radioactivity in Food and the Environment (RIFE) reports 2018," October 2018. [Online]. Available: https://www.gov.uk/government/publications/radioactivity-in-food-and-the-environment-rife-reports.

89. Environment Agency, "RSR: Principles of optimisation in the management and disposal of radioactive waste, Version 2," April 2010. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296495/LIT_8452_a9c510.pdf.

90. SEPA, "Satisfying the optimisation requirement and the role of Best Practicable Means, Version 2.0," May 2019. [Online]. Available: https://www.sepa.org.uk/media/101545/satisfying_the_alara_requirement_and_the_role_of_best_practicable_mean.pdf.

91. Environment Agency, "Criteria for setting limits on the discharge of radiaoctive waste from nuclear sites," June 2012. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296486/geho0612buqp-e-e.pdf.

92. EA, SEPA, NIEA, PHE and FSA, "Prospective Public Doses arising from Authorised Discharges of Radioactive Waste to the Environment," August 2012. [Online]. Available:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296390/geho1202bklh-e-e.pdf.

93. HSE, "Reducing Risks, Protecting People; HSE's Decision Making Process," 2001. [Online]. Available: https://www.hse.gov.uk/risk/theory/r2p2.pdf.

94. HSE, "The tolerability of risk from nuclear power stations," 1992. [Online]. Available: http://www.onr.org.uk/documents/tolerability.pdf.

95. Environment Agency, "Radioactive Substances Regulation, Environmental Principles," April 2010. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296388/geho0709bqsb-e-e.pdf.

96. Northern Ireland Executive, "The Radioactive Substances (Basic Safety Standards) Regulations (Northern Ireland) 2003, SI 2003/208," 2003. [Online]. Available: http://www.legislation.gov.uk/nisr/2003/208/contents/made.

97. DECC, "UK Strategy for Radioactive Discharges," July 2009. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/249884/uk_strategy_for_radioactive_discharges.pdf.

98. DECC, "Statutory Guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment," July 2009. [Online]. Available: https://webarchive.nationalarchives.gov.uk/20121217181219/http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/nuclear/radioactivity/dischargesofradioactivity/1_20091202160019_e_@@_guidanceearadioactivedischarges.pdf.

99. Scottish Government, "Environment Act 1995 - The UK strategy for radioactive discharges: Statutory Guidance," February 2008. [Online]. Available: https://www.gov.scot/publications/environment-act-1995-uk-strategy-radioactive-discharges-statutory-guidance/pages/2/.

BEIS, "UK strategy for radioactive discharges: 2018 review of the 2009 strategy," June 2018. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718723/2018Rev2009UKStratRadDischargeFin.pdf.

100. UK Government, "The Radiation (Emergency Preparedness and Public Information) Regulations 2019, SI 2019/703," 2019. [Online]. Available: http://www.legislation.gov.uk/uksi/2019/703/contents/made.

101. ONR and HSE, "Approved Code of Practice and Guidance for The Radiation (Emergency Preparedness and Public Information) Regulations," 2019. [Online]. Available: http://www.onr.org.uk/documents/2019/reppir-19-acop-and-guidance.pdf.

102. BEIS, "National Nuclear Emergency Planning and Response Guidance," October 2015. [Online]. Available: https://www.gov.uk/government/publications/national-nuclear-emergency-planning-and-response-guidance.

103. UK Government, "Sustainable Development, the UK's Strategy, Cm 2426," January 1994.

104. BEIS, "Radioactive contaminated land: Statutory guidance," June 2018. [Online].

Available:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718848/RCL_Statutory_Guidance_Final_220618.pdf.

105. DEFRA, “Environmental Protection Act 1990: Part 2A; Contaminated Land Statutory Guidance, PB13735, April 2012,” April 2012. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/223705/pb13735cont-land-guidance.pdf.

106. ONR, “Land use planning - Nuclear installations,” [Online]. Available: http://www.onr.org.uk/land-use-planning.htm.

107. EA & NIEA, “Guidance on Requirements for Authorisation of Geological Disposal Facilities on Land for Radioactive Wastes,” February 2009. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296504/geho0209bpjm-e-e.pdf.

108. UK Government, “Freedom of Information Act 2000, SI 2000/36,” [Online]. Available: http://www.legislation.gov.uk/ukpga/2000/36/contents.

109. Scottish Government, “Freedom of Information (Scotland) Act 2002,” SI 2002/13,” 2002. [Online]. Available: http://www.legislation.gov.uk/asp/2002/13/contents.

110. UK Government, “Hazardous substances,” December 2016. [Online]. Available: https://www.gov.uk/guidance/hazardous-substances.

111. Scottish Government, “Planning Circular 3/2015: Planning controls for hazardous substances,” 24 November 2015. [Online]. Available: https://www.gov.scot/publications/circular-3-2015-planning-controls-hazardous-substances/pages/2/.

112. UK Government, “The Planning (Hazardous Substances) Regulations 1992, SI 1992/656,” 1992. [Online]. Available: http://www.legislation.gov.uk/uksi/1992/656/contents/made.

113. ONR and EA, “Regulatory scrutiny and engagement for geological disposal: Annual report 2018/19,” October 2019. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/842315/Scrutiny_of_RWM_s_work_on_geological_disposal_-_annual_report_2018_to_2019.pdf.

114. Norwegian Radiation Protection Authority , “European ERICA Assessment Tool,” 2015. [Online]. Available: http://www.erica-tool.com/erica/.

115. ONR, “Notifying and reporting incidents and events to ONR,” 2019. [Online]. Available: http://www.onr.org.uk/operational/inspection/onr-opex-gd-001.pdf.

116. UK Government, “The Shipments of Radioactive Substances (EU Exit) Regulations 2019, SI 2019/571,” 2019. [Online]. Available: http://www.legislation.gov.uk/uksi/2019/571/contents/made.

117. UK Government, “The Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997, SI 1997/2367,” 1997. [Online]. Available: http://www.legislation.gov.uk/uksi/1997/2367/contents/made.

118. European Commission, "Setting up a Community regime for the control of exports of dual-use items and technology, EC regulation No.1334/2000," June 2000. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32000R1334.

119. UK Government, "The Dual-Use Items (Export Control) Regulations 2000, SI 2000/2620," 2000. [Online]. Available: http://www.legislation.gov.uk/uksi/2000/2620/contents/made.

120. IAEA, "Guidelines for Transfers of nuclear-related dual-use equipment, materials, software, and related technology, INFCIRC/254/Rev.10/Part2," November 2016. [Online]. Available: https://www.iaea.org/sites/default/files/publications/documents/infcircs/1978/infcirc254r10p2.pdf.

121. European Commission, "Regulation on shipments of radioactive substances between Member States, 1493/93/Euratom," June 1993. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31993R1493.

122. European Commission, "Control of high-activity sealed radioactive sources and orphan sources, Directive No. 2003/122/Euratom," December 2003. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32003L0122.

123. European Commission, "Council Directive laying down basic safety standards for the protection against dangers arising from exposure to ionising radiations, etc., 2013/59/Euratom," December 2013. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1506099341509&uri=CELEX:32013L0059.

124. DECC, "High-activity Sealed Radioactive Sources and Orphan Sources Directive (Council Directive 2003/122/Euratom) - Guidance to the Environment Agency," October 2005. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/466928/HASS_and_Orphan_sources_guidance_to_EA.pdf.

125. European Commission, "Industrial emissions (integrated pollution prevention and control),", Directive No. 2010/75/EU," November 2010. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32010L0075.

126. Environment Agency, "SR2017 No1: Unintentional receipt of radioactive materials and radioactive waste by the operator of any facility which uses a radiation detection system," March 2018. [Online]. Available: https://www.gov.uk/government/publications/sr2017-no1-unintentional-receipt-of-radioactive-materials-and-radioactive-waste-by-the-operator-of-any-facility-which-uses-a-radiation-detection-syst.

127. Environment Agency, "Regulatory position statement 155_15 - The management of radioactive items found in scrap metal," 155_15, Version 2," May 2016. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/842534/WITHDRAWN-RPS-management-of-radioactive-items-found-in-scrap-metal.pdf.

128. EA, SEPA, NRW and NIEA, "Exemption guidance - Small sealed radioactive sources etc., Version 1," September 2011. [Online]. Available: https://naturalresources.wales/media/2062/small-radioactive-sources-eng.pdf.

129. IAEA, “Integrated Regulatory Review Service (IRRS) to the United Kingdom, 14-25 October 2019 (Revision 1),” 2020. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/899129/irrs-report-2020-to-uk.pdf.

130. BEIS, “Integrated Regulatory Review Service (IRRS) mission 2019: Government response,” 2020. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/899149/irrs-government-response-to-2020-mission-report.pdf.

131. BEIS, “Euratom Exit Factsheet - Nuclear Cooperation Agreement,” June 2018. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/717194/euratom-exit-factsheet-nuclear-cooperation-agreement.pdf.

132. NDA, “Dounreay learning shared at Japanese fast reactor,” October 2019. [Online]. Available: https://nda.blog.gov.uk/2019/10/17/dounreay-learning-shared-at-japanese-fast-reactor/.

133. UK Government, “Nuclear Industrial Strategy - The UK’s nuclear future,” 2013. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/168048/bis-13-627-nuclear-industrial-strategy-the-uks-nuclear-future.pdf.

134. ONR, “Office for Nuclear Regulation Annual Report and Accounts 2016/17,” July 2017. [Online]. Available: http://www.onr.org.uk/documents/2017/onr-annual-report-and-accounts-2016-17.pdf.

135. Cogent, “Nuclear Safety Regulators - National Occupational Standards Development Research Report 2008,” 2008. [Online]. Available: http://dev.cogent-lifescience.co.uk/media/226529/Nuclear_Safety_Regulator_Report_Final_27.10.08.pdf.

136. NDA, “NDA business plan for 1 April 2020 to 31 March 2023,” April 2020. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/880822/NDA_Business_Plan_22_04_20_V3.pdf.

137. Radioactive Waste Management, “Corporate Strategy 2019: Our approach to provide a safer future by managing radioactive waste effectively, to protect people and the environment,” 2015. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/835903/RWM_Corporate_Strategy_2019_a.pdf.

138. UK Government, “Nuclear Industry Council,” [Online]. Available: https://www.gov.uk/government/groups/nuclear-industry-council.

139. Nuclear Institute, “Safety Directors’ Forum,” [Online]. Available: https://www.nuclearinst.com/safety-directors-forum.

140. Committee on Radioactive Waste Management, “Managing our Radioactive Waste Safely,” July 2006. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/294118/700_-_CoRWM_July_2006_Recommendations_to_Government_pdf.pdf.

141. Committee on Medical Aspects of Radiation in the Environment, [Online]. Available: https://www.gov.uk/government/groups/committee-on-medical-aspects-of-radiation-in-the-environment-comare.

142. UK Government, "Energy Act 2013, SI 2013/32," 2013. [Online]. Available: http://www.legislation.gov.uk/ukpga/2013/32/contents.

143. UK Government, "The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009, SI 2009/1348," 2009. [Online]. Available: http://www.legislation.gov.uk/uksi/2009/1348/contents/made.

144. UK Government, "The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment (Amendment) Regulations 2011, SI 2011/1885," 2011. [Online]. Available: http://www.legislation.gov.uk/uksi/2011/1885/contents/made.

145. UK Government, "The Carriage of Dangerous Goods (Amendment) Regulations 2019," 2019. [Online]. Available: http://www.legislation.gov.uk/ukdsi/2019/9780111177792/contents.

146. Northern Ireland Executive, "The Health and Safety at Work (Northern Ireland) Order 1978, SI 1978/1039," 1978. [Online]. Available: http://www.legislation.gov.uk/nisi/1978/1039/contents.

147. Northern Ireland Executive, "Carriage of Dangerous Goods and Use of Transportable Pressure Equipment (Northern Ireland) Regulations 2010, SI 2010/160," 2010. [Online]. Available: http://www.legislation.gov.uk/nisr/2010/160/contents/made.

148. Northern Ireland Executive, "The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment (Amendment) Regulations (Northern Ireland) 2011, SI 2011/365," 2011. [Online]. Available: http://www.legislation.gov.uk/nisr/2011/365/contents/made.

149. UK Government, "Merchant Shipping Act 1995, SI 1995/21," 1995. [Online]. Available: http://www.legislation.gov.uk/ukpga/1995/21/contents.

150. Maritime and Coastguard Agency, "MCA enforcement policy statement," May 2014. [Online]. Available: https://www.gov.uk/government/publications/mca-enforcement-policy-statement.

151. Maritime and Coastguard Agency, "Merchant Shipping Notice MSN 1875 (M) The Carriage of Dangerous Goods and Marine Pollutants in Packaged Form: Amendment 38-16 to the International Maritime Dangerous Goods (IMDG) Code," December 2016. [Online]. Available: https://www.gov.uk/government/publications/msn-1875-the-carriage-of-dangerous-goods-and-marine-pollutants-in-packaged-form.

152. UK Government, "Merchant Shipping (Carriage of Packaged Irradiated Nuclear Fuel etc.) (INF Code) Regulations 2000, SI 2000/3216," 2000. [Online]. Available: http://www.legislation.gov.uk/uksi/2000/3216/contents/made.

153. UK Government, "The Merchant Shipping (Port State Control) Regulations 2011, SI 2011/2601," 2011. [Online]. Available: http://www.legislation.gov.uk/uksi/2011/2601/contents/made.

154. UK Government, "The Merchant Shipping (Survey and Certification) Regulations

2015, SI 2015/508," 2015. [Online]. Available: http://www.legislation.gov.uk/uksi/2015/508/contents/made.

155. UK Government, "Civil Aviation Act 1982, SI 1982/16," 1982. [Online]. Available: http://www.legislation.gov.uk/ukpga/1982/16/contents.

156. UK Government, "The Air Navigation Order 2016, SI 2016/765," 2016. [Online]. Available: http://www.legislation.gov.uk/uksi/2016/765/contents/made.

157. UK Government, "The Air Navigation (Dangerous Goods) Regulations 2002, SI 2002/2786," 2002. [Online]. Available: http://www.legislation.gov.uk/uksi/2002/2786/contents/made.

158. UK Government, "The Air Navigation (Dangerous Goods) (Amendment) Regulations 2019, SI 2019/922," 2019. [Online]. Available: http://www.legislation.gov.uk/uksi/2019/922/contents/made.

159. M P Harvey, "Radiological Consequences Resulting from accidents and Incidents Involving the Transport of Radioactive Materials in the UK - 2009 review," August 2010. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/340167/HPA-CRCE-003_for_website.pdf.

Abbreviations and Acronyms

Acronym	Full term
ABWR	Advanced Boiling Water Reactor
ACOP	Approved Code Of Practice
ADN	European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterway
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
AGR	Advanced Gas-cooled Reactor
AGROP	Advanced Gas-cooled Reactor Operating Programme
ALARA	As Low As Reasonably Achievable
ALARP	As Low As Reasonably Practicable
ANT	Advanced Nuclear Technology
ARC	Alpha Resilience and Capability
ASN	Autorité de Sûreté Nucleaire (French Nuclear Safety Authority)
ATCS	Ambient Temperature Conditioning System
AVDS	Advanced Vacuum Drying System
AWE	Atomic Weapons Establishment
BAT	Best Available Techniques
BEIS	The UK Government Department for Business, Energy & Industrial Strategy
BEP	Box Encapsulation Plant
BEPPS	Box Encapsulation Plant Product Store
BMS	Business Management System
BNFL	British Nuclear Fuels Ltd
BPEO	Best Practicable Environmental Option
BPM	Best Practicable Means
BSO	Basic Safety Objective
BSSD 96	EC Basic Safety Standards Directive 96/29/Euratom
BSSD 2013	EC Basic Safety Standards Directive 2013/59/Euratom
C&M	Care & Maintenance
CA	Competent Authority
CAA	Civil Aviation Authority
CBA	Cost Benefit Analysis
CDG	Carriage of Dangerous Goods
CDG(NI)	Carriage of Dangerous Goods (Northern Ireland)
CDM	Career and Development Manager

CDT	Centre for Doctoral Training
CEAR	Compilation of Environment Agency Requirements
CFP	Cavendish Fluor Partnership
CHILW	Contact-Handled Intermediate Level Waste
CIDI	Central Index of Dose Information
CLESA	Calder Landfill Extension Segregated Area
CNI	Chief Nuclear Inspector
CNS	Convention on Nuclear Safety
CNS Report	UK's National Report on Compliance with the Convention on Nuclear Safety
COBR, COBRA	Cabinet Office Briefing Room, where the Civil Contingencies Committee convenes
COMAH	Control of Major Accident Hazards
COMARE	Committee on Medical Aspects of Radiation in the Environment
COMDEC	IAEA International Project on Completion of Decommissioning
CORE	Control of Occupational Radiation Exposure
CoRWM	Committee on Radioactive Waste Management
COSHH	Control of Substances Hazardous to Health
CP	Contracting Party
CRCE	Centre for Radiation, Chemical and Environmental Hazards, part of Public Health England
CRWG	Community Representation Working Group
CT	Counter Terrorist
CTMIR	CT Major Incident Room
CTPOR	CT Police Operations Room
DAERA	Department of Agriculture, Environment and Rural Affairs (Northern Ireland)
DBA	Design Basis Accident
DCIC	Ductile Cast Iron Container
DCP	Dounreay Cementation Plant
DECC	The UK Government Department of Energy and Climate Change (now BEIS)
DEFRA	The UK Government Department for Environment, Food and Rural Affairs
DFR	Dounreay Fast Reactor
DFS	Dry Fuel Store
DfT	The UK Government Department for Transport
DGD	Dangerous Goods Division (of DfT)
DoH	The UK Government Department of Health
DRS	Direct Rail Services (a subsidiary of the NDA)
DSRL	Dounreay Site Restoration Limited
DWP	Department for Work and Pensions

EA	The Environment Agency
EA95	The Environment Act 1995
EASR18	Environmental Authorisations (Scotland) Regulations 2018
EARP	Enhanced Actinide Removal Plant, located at Sellafield
EC	European Commission
EDF(NG)	Électricité de France Nuclear Generation Limited
EDRAM	Environmentally Safe Disposal of Radioactive Material
EEA	European Economic Area
EIA	Environmental Impact Assessment
EIADR	Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999 (amended in 2006 and 2018)
ELG	Executive Liaison Group
EMM	Enforcement Management Model
ENSREG	European Nuclear Safety Regulators Group
EOC	(The UK Government) Emergency Operation Centre
EPA90	Environmental Protection Act 1990
EPD	Electronic Personal Dosimeter
EPO	Environmental Protection Officer
EPR	European Pressurised Water Reactor
EPR10	Environmental Permitting Regulations 2010
EPR16	Environmental Permitting Regulations 2016
EPS	Enforcement Policy Statement
ES	Environmental Statement
ESC	Environmental Safety Case
EU	European Union
EURAD	European Joint Programme on Radioactive Waste Management
FDP	Funded Decommissioning Programme
FFI	Fee For Intervention
FGASP	First Generation AGR Storage Pond
FGMSP	First Generation Magnox Storage Ponds
FGOSP	First Generation Oxide Fuel Storage Pond
FHP	Fuel Handling Plant
FINAS	Fuel Incident Notification Analysis System
FLoC	Final Letter of Compliance
FOIA2000	Freedom of Information Act 2000
FSA	Food Standards Agency
FSS	Food Standards Scotland

GB	Great Britain
GDA	Generic Design Assessment
GDF	Geological Disposal Facility
gDSSC	Generic Disposal System Safety Case
GLEEP	Graphite Low Energy Experimental Pile
GLO	Government Liaison Officer
GOGO	Government-Owned, Government-Operated
Government	The UK Government and the devolved administrations of Scotland, Wales and Northern Ireland, unless stated otherwise
GRA	Guidance on Requirements for Authorisation
GRR	Guidance on Requirements for Release of nuclear sites from radioactive substances regulation
GSR	General Safety Requirements
GTA	Government Technical Adviser
HA	Highly-Active
HAL	Highly-Active Liquor
HALES	Highly-Active Liquor Evaporation and Storage plant at Sellafield
HASS	High Active Sealed Sources
HASS Regulations	High-activity Sealed Radioactive Sources and Orphan Sources Regulations 2005
HAW	Higher Activity Waste, HAW is defined by UK Government as the collection of: HLW, ILW, and the relatively small proportion of LLW that is not currently suitable for disposal in existing LLW disposal facilities (due to some chemical, physical or radiological property that is incompatible with the extant waste acceptance criteria).
HERCA	Heads of European Radiation protection Competent Authorities
HEU	Highly-Enriched Uranium
HIP	Hot Isostatic Pressing
HLW	High-Level Waste (Radioactive waste, typically the by-product from the reprocessing of spent fuel, which is sufficiently radioactive that it generates a significant amount of heat (typically thermal power above about 2kW/m^3) which has to be taken into account for its storage and disposal)
HPC	Hinkley Point C
HSE	Health and Safety Executive
HSENI	Health and Safety Executive Northern Ireland
HSSSEQ	Health, Safety, Security, Safeguards, Environment and Quality
HSW(NI)078	Health and Safety at Work (Northern Ireland) Order 1978
HSWA74	Health and Safety at Work etc. Act 1974
IAEA	International Atomic Energy Agency
ICAO	International Civil Aviation Authority

ICRP	International Commission on Radiological Protection
IEA	Information Exchange Agreements
IGD-TP	Implementing Geological Disposal of Radioactive Waste Technology Platform
ILW	Intermediate-Level Waste (Radioactive waste with radioactive levels exceeding the upper boundaries for LLW, but which does not require heating to be taken into account for its storage)
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organisation
IN	Improvement Notice
INES	International Nuclear and Radiological Event Scale
INF Code	Safe Carriage of Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships
INRA	International Nuclear Regulators' Association
INS	International Nuclear Services
IPRI	Industrial Pollution and Radiochemical Inspectorate
IPT	Integrated Project Team
IRR	Ionising Radiations Regulations
IRRNI	Ionising Radiations Regulations Northern Ireland
IRRS	Integrated Regulatory Review Service
IRS	International Reporting System for Operating Experience
IRX	Inter-Reactor Fuel Transfer
ISFSI	Independent Spent Fuel Storage Installation, under construction at Sizewell B (also known as DFS)
ISO	Intermodal Shipping Container
IWS	Integrated Waste Strategy
JAEA	Japanese Atomic Energy Agency
JC	Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
LAW	Lower Activity Waste (Collective term for radioactive waste comprising LLW and VLLW)
LC	Licence Condition under the Nuclear Installations Act 1965
LEU	Low-Enriched Uranium
LGD	Lead Government Department
LLW	Low-Level Waste (Radioactive waste with radioactive content not exceeding 4 GBq/tonne of alpha activity, or 12 GBq/tonne of beta/gamma activity; see paragraphs x—y)
LLWR Ltd	LLWR Limited, the Site Licensee Company for the UK Low Level Waste Repository near Drigg in Cumbria

LoC	Letter of Compliance
LP&S	Legacy Ponds and Silos, located at Sellafield
LSTP	Local Sludge Treatment Plant (Sellafield)
LTP	Lifetime Plan
LWR	Light Water Reactor
MAETP	Modular Active Effluent Treatment Plant
MBGWS	Miscellaneous Beta-Gamma Waste Store
MCA	Maritime and Coastguard Agency
MCI	Miscellaneous Contaminated Items
MEB	Multi-Element Bottle
MEP	Magnox Encapsulation Plant, located at Sellafield
MHCLG	Ministry of Housing, Communities and Local Government
MHSW99	The Management of Health and Safety at Work Regulations 1999
microGy	microGray
MILWEP	Modular ILW Encapsulation Plant
MoD	Ministry of Defence
MOP	Magnox Operating Programme
MoU	Memorandum of Understanding
MOX	Mixed-Oxide (fuel)
MRDU	Mobile Radiation Detection Unit
MRF	Metals Recycling Facility
MRWS	Managing Radioactive Waste Safely
MS	Management System
MSA95	Merchant Shipping Act 1995
MSN	Merchant Shipping Notice 1875
MSSS	Magnox Swarf Storage Silo
mSv	milliSievert
MTR	Materials Test Reactor (at Dounreay and other locations in the UK)
NAIR	National Arrangements for Incidents involving Radioactivity (for orphan sources)
NCA	Nuclear Cooperation Agreement
NCC	News Coordination Centre
NDA	Nuclear Decommissioning Authority
NDPB	Non-Departmental Public Body
NDSPG	Nuclear Decommissioning Strategy and Policy Group
NEA	Nuclear Energy Agency
NEAF	Nuclear Emergency Arrangements Forum
NEBR	Nuclear Emergency Briefing Room

NEP&R	Nuclear Emergency Planning and Response
NEPLG	Nuclear Emergency Planning Liaison Group
NERC	Natural Environment Research Council
NESA	Nuclear Energy Skills Alliance
NI	Northern Ireland
NIA65	Nuclear Installations Act 1965
NIC	Nuclear Industry Council
NIEA	Northern Ireland Environment Agency
NII	Nuclear Installations Inspectorate (historically a part of HSE's Nuclear Directorate, which on 1 April 2011 became part of the Office for Nuclear Regulation)
NITAG	Northern Ireland Technical Advisors Group
NLF	Nuclear Liabilities Fund
NLFAB	Nuclear Liabilities Financing Assurance Board
NMP	Nuclear Management Partners
NNB	Nuclear New Build
NNL	National Nuclear Laboratory
NORM	Naturally Occurring Radioactive Material
NPCC	National Police Chiefs Council
NPS	Nuclear National Policy Statement
NR	National Report
NRCC	Nuclear Resilience Coordination Committee
NRG	Nuclear Regulation Group (within the EA)
NRI	Nuclear Research Index
NRN	Nuclear Research Needs
NRW	Natural Resources Wales
NSA	National Skills Academy
NSG	Nuclear Suppliers Group
NSIP	Nationally Significant Infrastructure Project
NSSG	Nuclear Skills Strategy Group
NTEC	Nuclear Technology Education Consortium
NWA	Nuclear Workforce Assessment
NWP	National nuclear LLW programme
OCNS	Office for Civil Nuclear Security
OECD	Organisation for Economic Co-operation and Development
OELG	Operational Experience Liaison Group
ONR	The Office for Nuclear Regulation
OPEX	Operational Experience

OSPAR	The Convention for the Protection of the marine Environment of the North-East Atlantic (the 'OSPAR Convention') was open for signature at the Ministerial Meeting of the Oslo and Paris Commissions in Paris on 22 September 1992
PBO	Parent Body Organisation
PCM	Plutonium-Contaminated Material
PCSR	Pre-Construction Safety Report
PFCS	Pile Fuel Cladding Silo
PFR	Dounreay Prototype Fast Reactor
PFSP	Pile Fuel Storage Pond
PIE	Post-Irradiation Examination
PN	Prohibition Notice
PNTL	Pacific Nuclear Transport Limited
POCO	Post Operational Clean Out
POSR	Pre-Operational Safety Report
PSA	Probabilistic Safety Analysis
PSR	Periodic Safety Review
PWR	Pressurised Water Reactor
QA	Quality Assurance
R&D	Research and development
R2P2	'Reducing risks, protecting people: HSE's decision-making process'
RAM	Radioactive Materials
RANET	Response and Assistance Network
RATE	Radioactivity and the Environment
RCIS	ONR’s Redgrave Court Incident Suite
RED	Restructuring Effective Date
REPPIR	Radiation (Emergency Preparedness and Public Information) Regulations 2019
REPs	Radioactive Substances Regulation Environmental Principles
ResCG	Response Coordinating Group
RGW	Recovery Coordinating Group
RHILW	Remote-handled ILW
RID	Regulations concerning the International Carriage of Dangerous Goods by Rail
RIFE	Radioactivity in Food and the Environment
RIMNET	Radiation Incident Monitoring Network
RM	Review Meeting
ROV	Remotely Operated Vehicle
RPS	Regulatory Position Statement

RSA93	Radioactive Substances Act 1993
RSPG	Radioactive Substances Policy Group
RSR	Radioactive Substances Regulation
RSRL	Research Sites Restoration Ltd (now part of Magnox)
RSS	Radioactive Substances Strategy
RST	Redundant Settling Tank
RWI	Radioactive Waste Inventory
RWM	Radioactive Waste Management Limited (a wholly-owned subsidiary of the NDA), responsible for delivery of a geological disposal facility
RWMC	Radioactive Waste Management Case
SAA	Severe Accident Analysis
SAGE	Scientific Advisory Group for Emergencies
SAPs	Safety Assessment Principles
SCC	Strategic Co-ordination Centre
SCG	Strategic Coordinating Group
SCP	SIXEP Continuity Plant
SDF	Safety Directors' Forum
SEP	Salt Evaporator Plant (Sellafield)
SEPA	Scottish Environment Protection Agency
SES-SSG	Site End State Strategic Steering Group
SETP	Segregated Effluent Treatment Plant
SFAIRP	So Far As Is Reasonably Practicable
SFL	Springfields Fuels Limited
SGHWR	Steam-Generating Heavy Water Reactor
SGoRR	Scottish Government Resilience Room
SI	Statutory Instrument
SIXEP	Sellafield Ion Exchange Plant
SLC	Site Licence Company
SNM	Special Nuclear Materials
SOF	Store Operations Forum
SPP	Sludge Packaging Plant
SPRS	Sellafield Product and Residue Store
SQEP	Suitably Qualified and Experienced Person
SSA	Strategic Siting Assessment
SSC	Structure, System & Component
STAC	Scientific and Technical Advice Cell
STEM	Science, Technology, Engineering and Mathematics
STP	Solvent Treatment Plant (Sellafield)

STUK	Säteilyturvakeskus
SWB	Sizewell B nuclear power station
SWESC	Site Wide Environmental Safety Case
TAG	Technical Assessment Guide
Te TeU	Tonne Tonne Uranium
TEA13	The Energy Act 2013
THORP	Thermal Oxide Reprocessing Plant (located at Sellafield)
TIG	Technical Inspection Guide
TMF	Tails Management Facility
TOR	Tolerability of Risk
TR&S	THORP Receipt and Storage Pond
TSF	Technical Support Framework
UCP	Urenco Chemical Plants Limited, at Urenco Capenhurst
UF6	Uranium hexafluoride
UK	The United Kingdom of Great Britain and Northern Ireland
UKAEA	United Kingdom Atomic Energy Authority
UKNWM	UK Nuclear Waste Management Ltd
UKRI	UK Research and Innovation
UKRWI	UK Radioactive Waste Inventory
UKSRD09	UK Strategy for Radioactive Discharges, 2009
UNS	Urenco Nuclear Stewardship
US / USA	The United States of America
USNRC	United States Nuclear Regulatory Commission
UUK	Urenco UK Limited
VLLW	Very-Low-Level Waste (A sub-sub-category of LLW with specific activity limits. VLLW can disposed at permitted landfill facilities).
VR	Virtual Reality
WAGR	Windscale Advanced Gas-cooled Reactor
WAMAC	Waste Monitoring and Compaction Plant
WASSC	Waste Safety Standards Committee
WENRA	Western European Nuclear Regulators' Association
WEP	Waste Encapsulation Plant, located at Sellafield
WiN	Women in Nuclear
WMP	Waste Management Plan
WPEP	Waste Processing and Encapsulation Plant
WTC	Waste Treatment Complex

WVP	Waste Vitrification Plant, located at Sellafield
ZEBRA	Zero Energy Breeder Reactor Assembly

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