The Sizewell C Project

6.3 Volume 2 Main Development Site

Chapter 7 Spent Fuel and Radioactive Waste Management

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7. Spent Fuel and Radioactive Waste Management

7.1 Introduction

7.1.1 This chapter of **Volume 2** of the **Environmental Statement** (**ES**) presents an overview of the proposed arrangements for the management of radioactive wastes and spent fuel arising during operation of the Sizewell C power station. No radioactive waste would be generated during the construction of the Sizewell C power station, albeit there is the potential for some radioactive waste to be generated during the demolition of the existing Sizewell B outage store as part of the Sizewell B relocated facilities proposals. This is further described in **Chapter 15** of the Sizewell B relocated facilities **ES** as provided in **Volume 1, Appendix 2A** of the **ES**.

7.1.2 Wastes generated during decommissioning are discussed in **Chapter 5** of this volume. Potential radiological effects resulting from gaseous and liquid discharges, and from the storage and transport of solid wastes are summarised as part of the assessment presented within **Chapter 25** of this volume.

7.1.3 Operation and decommissioning of the Sizewell C power station would result in the unavoidable generation of quantities of radioactive waste and spent fuel. This is a known and justifiable consequence of nuclear power generation and the UK regulatory permissions regime for nuclear power stations defines precise regulatory requirements and expectations for the management of this waste.

7.1.4 SZC Co. has applied the principles of waste minimisation, so far as is reasonably practicable, in the design of the Sizewell C power station. Wherever reasonably practicable, measures will be taken to prevent materials either becoming radioactively contaminated or activated, or as being classified as radioactively contaminated due to the inadvertent placement of inert material adjacent to radioactive material.

7.1.5 Waste processing systems have been specified to treat radioactive liquid and gaseous effluents and discharges and solid wastes, in order to reduce the environmental impact to as low as reasonably achievable prior to disposal. The activity and volume of radioactive wastes discharged and disposed of shall be minimised through the application of Best Available Techniques (BAT), and the use of the waste hierarchy. Furthermore, the disposal of radioactive wastes would be permitted and monitored by the Environment Agency under the Radioactive Substances Regulations permit.

7.1.6 SZC Co.'s strategy will be to manage and process radioactive wastes as they arise where this is reasonably practicable, thereby reducing risks and preventing the creation of a legacy that has to be dealt with by future generations. The approach to radioactive waste management has been developed based on lessons learnt from the operation and decommissioning of the UK's early nuclear power stations.

7.1.7 The rest of this chapter will cover:

- legislation, policy and guidance;
- introduction to radioactive waste and spent fuel;
- Sizewell C **Integrated Waste Strategy**;
- high-level strategy for Sizewell C radioactive wastes;
- management of radioactive waste generated during the operation of the Sizewell C UK EPR™;
- Intermediate Level Waste (ILW);
- long-term management of ILW;
- spent fuel; and
- additional Information on likely effects.

7.2 Legislation, policy and guidance

7.2.1 This section summarises the policies and requirements of regulatory authorities that SZC Co. works with regarding the management of radioactive wastes and spent fuel.

7.2.2 The management of wastes on a nuclear licensed site is the sole responsibility of the waste producer (i.e. the operator and site licensee). It is the waste producer that implements appropriate waste management operations on the power station site in compliance with legislation, policy and guidance. The UK Government, regulators and technical authorities have the following roles:

- the UK Government enacts legislation and publishes policy and guidance to transpose international agreements and guidance into UK practice (refer to **Table 7.1** and **Table 7.2**);
- Nuclear Decommissioning Authority (NDA) specifies requirements for the treatment and disposal of radioactive waste; and
- other nuclear regulators (Environment Agency and Office for Nuclear Regulation) enforce the radioactive waste legislation and ensure that policies are implemented.

7.2.3 The management of radioactive waste is a highly regulated activity with robust legislation in place to minimise any adverse effect on human health and the environment. All radioactive waste associated with the Sizewell C power station would be managed in accordance with legislation as enforced by the relevant regulators.

7.2.4 There are several regulators overseeing the proper management of radioactive wastes that would be generated by the Sizewell C Project. The regulators have different roles and responsibilities depending on the category of waste produced.

- The Office for Nuclear Regulation (ONR) regulates on-site radioactive waste management through conditions attached to the Nuclear Site Licence. The ONR consults the Environment Agency regarding radioactive waste management activities and would not issue the Nuclear Site Licence (to the nuclear site operator) without taking full and meaningful account of any environmental issues raised.
- The Environment Agency regulates radioactive disposals (including the discharge of gaseous and aqueous emissions), and the transfer of radioactive wastes between the power station and waste treatment, and disposal sites in England in line with the arrangements set out within the Environmental Permitting Regulations 2016.
- The NDA is responsible for the decommissioning and clean-up of all legacy civil nuclear sites in the UK, including the management of radioactive wastes. The NDA establishes waste management plans with the operator and consults on these plans with the relevant regulators. The NDA has overall responsibility for the implementation of UK lower activity waste policy, including the operation of the Low Level Waste (LLW) Repository near Drigg in Cumbria. The NDA is also responsible for the implementation of the UK higher activity waste policy including the future operation of the Geological Disposal Facility via its subsidiary Radioactive Waste Management Ltd. The NDA will advise the Department for Business, Energy and Industrial Strategy (BEIS) on the quality of decommissioning plans and associated cost estimates, as required for new nuclear power stations under the UK Government Funded Decommissioning Programme (FDP) arrangements (Ref. 7.1).

7.2.5 **Table 7.1** lists the main UK legislation relevant to the management of radioactive waste and spent fuel. **Table 7.2** identifies the main UK national strategy, policies and guidance that apply to the management of spent fuel and radioactive wastes, and therefore would be integral to SZC Co.'s approach to this topic.

Table 7.1: UK Legislation relevant to radioactive waste and spent fuel management.

Legislation Description.	Legislation Description.
Nuclear Installations Act 1965 (Ref. 7.2).	ONR grant Nuclear Site Licences under this Act, and have a standard set of licence conditions. The licence holder is required to comply with defined licence conditions, as per Schedule 2 of the standard Nuclear Site Licences, which ensure the safe operation and maintenance of a nuclear installation. Standard licence conditions relevant to the management of waste on a licensed site include: • LC4: Restrictions on nuclear matter on the site, "*The licensee shall ensure that no nuclear matter is stored on the site except in accordance with adequate arrangements made by the licensee for this purpose.*" • LC5: Consignment of nuclear matter, "*The licensee shall not consign nuclear matter (other than excepted matter and radioactive waste) to any place in the United Kingdom other than a relevant site except with the consent of ONR.*" • LC32: Accumulation of radioactive waste, "*The licensee shall make and implement adequate arrangements for minimising so far as is reasonably practicable the rate of production and total quantity of radioactive waste accumulated on the site at any time and for recording the waste so accumulated*" • LC33: Disposal of radioactive waste, "*The licensee shall, if so directed by ONR, ensure that radioactive waste accumulated or stored on the site is disposed of as ONR may specify and in accordance with an environmental permit, or an existing permit.*" • LC34: Leakage and escape of radioactive material and radioactive waste, "*The licensee shall ensure, so far as is reasonably practicable, that radioactive material and radioactive waste on the site is at all times adequately controlled or contained so that it cannot leak or otherwise escape from such control or containment*." • LC35: Decommissioning, "*The licensee shall make and implement adequate arrangements for the decommissioning of any plant or process which may affect safety*." The ONR is responsible for issuing Nuclear Site Licences as well as monitoring an operator's compliance with the licence conditions.
The Ionising Radiations Regulations 2017 (Ref. 7.3).	Under these regulations, the exposure to radiation of the public and workers must be below legal limits and must be shown to be as low as reasonably practicable (ALARP). In this context, doses to workers must be kept ALARP while operating radioactive waste systems or handling radioactive waste.
Energy Act 2008 (Ref. 7.4) and 2013 (Ref. 7.5).	Under section 45 of the Energy Act 2008, a person who applies for a Nuclear Site Licences to install or operate a nuclear power station must notify the Secretary of State of the application and prepare a FDP for approval. It is an offence under Section 47 of the Act for a person to use a site, by virtue of a nuclear site licence, without an approved FDP.

Legislation Description.	Legislation Description.
	The Energy Act 2013 established the ONR as the body responsible for the enforcement of statutory provisions within the Act in regard to nuclear regulation. This includes responsibilities for the issuing and regulation of nuclear site licences under the Nuclear Installations Act 1965 (as amended).
Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999 (as amended) (Ref. 7.6).	These regulations require nuclear power station operators to obtain consent from the ONR prior to the commencement of decommissioning. This requires the submission of an Environmental Statement and Environmental Impact Assessment and a period of consultation.
Environmental Permitting (England and Wales) Regulations 2016 (as amended) (Ref. 7.7).	These regulations seek to ensure that permitted activities and their discharges do not endanger the environment or human health. Environmental permits must be sought from the Environment Agency for both radioactive and conventional wastes and discharges. They combine the requirements for an integrated waste management approach and the requirements for hazardous waste management. They provide a framework for regulation that enables the Environment Agency and ONR (as well as other interested government or regulatory departments) to assess permitting and compliance with a common approach. These regulations apply to all wastes (radioactive and conventional), aqueous and gaseous emissions.
Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (Ref. 7.8).	This legislation incorporates the European Agreement concerning the International Carriage of Dangerous Goods by Road (Ref. 7.27) and the Regulations concerning the International Carriage of Dangerous Goods by Rail (Ref. 7.28). It defines the requirements for the safe transportation of radioactive waste materials.

Table 7.2: Main national strategy, policies and guidance relevant to radioactive waste and spent fuel.

Policy / Guidance	Description
Department of Energy and Climate Change (DECC), 2013. Long-term Nuclear Energy Strategy (Ref. 7.9).	The UK Long-term Nuclear Energy Strategy lays out the Government's policy on the use of nuclear energy as part of a low carbon future, including through the construction of new nuclear facilities. As part of this strategy, the Government lays out key priorities for the sector, including the issue of both legacy nuclear wastes, and the treatment of radioactive wastes from nuclear new build. This strategy builds upon the existing legislative requirements for new nuclear facilities to have a funded decommissioning programme in place prior to the granting of a nuclear site licence. The Government's commitment includes the establishment of the ONR to regulate the sector. With regards to radioactive waste management, the strategy assumes that spent fuel and ILW will be disposed of within the proposed national Geological Disposal Facility once the facility becomes available.

Policy / Guidance	Description
BEIS, 2018. UK Strategy for Radioactive Discharges (Ref. 7.10).	This strategy describes how the UK will continue to implement its obligations under the OSPAR Radioactive Substances Strategy objective for 2020-2030 namely for progressive and substantial reductions in radioactive discharges, radionuclide concentrations in the marine environment and human exposure to ionising radiations due to radioactive discharges.
Department of the Environment, 1995. The Review of Radioactive Waste Management Policy: Final Conclusions (Ref. 7.11).	From this policy, the following key principles arise: • radioactive wastes should not be unnecessarily created; • such wastes as are created should be safely and appropriately managed and treated; and • wastes should be safely disposed of at appropriate times and in appropriate ways. These are underpinned by general requirements that: • radioactive wastes should be managed and disposed of in ways which protect the public, workforce and the environment; and • radioactive waste management should safeguard the interest of existing and future generations and the wider environment, and in a manner that commands public confidence and takes due account of costs. The review is amended and replaced in parts by the Policy for the Long-Term Management of Solid Low-Level Radioactive Waste in the United Kingdom, 2007 (Ref. 7.12).
DECC, 2016. UK Strategy for the Management of Solid Low-Level Radioactive Waste from the Nuclear Industry (Ref. 7.12).	The aim of this strategy is to provide a high-level framework within which LLW management decisions can be taken flexibly to ensure safe, environmentally acceptable and cost-effective management solutions that reflect the nature of the LLW concerned. There are three strategic themes: • the application of the waste hierarchy; • the best use of existing LLW management assets; and • the need for new, fit-for-purpose waste management routes for LLW. This strategy is subject to periodic review and an updated strategy was issued in February 2016. The revised strategy is in line with the original version (for example based upon the waste hierarchy), whilst reflecting the changes to available options for the treatment of LLW since the issue of the original version.
ONR, 2015. The management of higher activity radioactive wastes on nuclear licensed sites (Ref. 7.13).	Joint guidance from the ONR, Natural Resources Wales, the Environment Agency and the Scottish Environmental Protection Agency is provided to nuclear licensees in addressing higher activity wastes throughout their lifecycle. The production of a Radioactive Waste Management Case is recommended by the guidance. It also includes guidance on waste management, characterisation and segregation,

Policy / Guidance	Description
	condition and disposability, storage of radioactive waste and managing information and records relating to waste.
DECC, 2011. Funded Decommissioning Programme Guidance for New Nuclear Power Stations (Ref. 7.1).	The Government legislated in the Energy Act 2008 to ensure that operators of new nuclear power stations have secure financing arrangements in place to meet the full costs of decommissioning and their full share of waste management and disposal costs. Before nuclear-related construction can begin on-site, an operator of a new nuclear power station must have a FDP in place approved by the Secretary of State. This guidance sets out the principles the Secretary of State will expect to see satisfied in the FDP prepared by an operator. The Guidance gives information on ways in which an operator might satisfy those principles, thereby assisting operators in understanding their obligations under the Energy Act 2008.
DECC, 2011. Waste Transfer Pricing Methodology (Ref. 7.14).	The purpose of the Waste Transfer Pricing Methodology is to set out how the waste transfer price will be determined. This methodology will form the basis of more detailed provisions to be set out in the waste contract that will be agreed between the government and the operator. It is intended to ensure that the entire costs of disposal now and in the future are met by the operator.
BEIS, 2018. Implementing Geological Disposal - Working with Communities (Ref. 7.15).	Sets out the UK Government's policy on managing higher activity radioactive waste through implementing geological disposal.
DECC, 2011. National Policy Statements (NPS) Energy EN-1 (Ref. 7.16).	This NPS, designated by the Secretary of State in July 2011, sets out the overarching national policy for delivery of major energy infrastructure projects. This forms the primary policy context for a decision on SZC Co.'s application for a Development Consent Order for the Sizewell C power station. There are no requirements relevant to radioactive waste management within NPS EN-1.
DECC, 2011. NPS Nuclear Power Generation EN-6 (NPS EN-6) (Ref. 7.17).	NPS EN-6, designated by the Secretary of State in July 2011, sets out national policy on new nuclear power stations identified as potentially suitable for deployment by 2025, and provides specific considerations with regard to radioactive waste (which are set out in section 2.11 and annex B of the NPS). This also forms the primary policy context for a decision on the Sizewell C Project application for a development consent order. EN-6, Section 2.11 recognises that "*The UK has robust legislative and regulatory systems in place for the management (including interim storage, disposal and transport) of all forms of radioactive waste that will be produced by new nuclear power stations*." "*As the licensing and permitting of nuclear power stations by the nuclear regulators is a separate regulatory process, the Examining Authority for the Development Consent Order should act on the basis that:*

Policy / Guidance	Description
	• *the relevant licensing and permitting regimes will be:* *properly applied and enforced; and* • *it should not duplicate the consideration of matters that are within the remit of the nuclear regulators."* In relation to long-term radioactive waste management, Annex B of NPS EN-6 sets out that other facilities for the interim storage of waste may come forward. "*However, in the absence of any proposal the IPC [Planning Inspectorate] should expect that waste would be on-site until the availability of a geological disposal facility*".
UK Safeguards Office, 2010. Guidance on International Safeguards and Nuclear Material Accountancy at Nuclear sites in the UK (Ref. 7.18).	The guidance includes nuclear material accountancy and safeguards best practice for the life of a nuclear plant from design to decommissioning. This guidance details safeguards reporting requirements for nuclear materials and implements Commission Regulation (Euratom) 302/2005 which detail the safeguards reporting requirements for nuclear materials.
DECC, 2004. The Decommissioning of the UK Nuclear Industry's Facilities (Ref. 7.19).	The UK Government updated its policy on the decommissioning of nuclear facilities in 2004 which stated that new facilities covered by the policy should be designed and built so as to minimise decommissioning and associated waste management operations and costs.
Suffolk Coastal District Local Plan Strategic Policy, Core Strategy & Development Management Policies, Development Plan Document (SP13), 2013	Sets out issues that the East Suffolk Council will consider in its local impact report. This includes: (n) On-site storage of nuclear waste

7.3 Introduction to radioactive waste and spent fuel

a) Radioactive materials

i. What is radioactivity?

7.3.1 All substances are made of atoms. These have electrons around the outside and a nucleus, consisting of protons and neutrons, in the middle. In some types of atom, the nucleus is unstable and decays over time into a more stable form of the atom. This is known as radioactive decay.

7.3.2 When an unstable nucleus decays, it may emit:

- an alpha particle; and
- a beta particle.

7.3.3 An unstable nucleus may also emit a gamma ray during an alpha, or beta decay.

7.3.4 The radioactivity of all nuclear materials decays with time. Each radionuclide contained in the nuclear material has a characteristic half-life (the time taken for half of its atoms to decay and thus for it to lose half of its radioactivity). Radionuclides with long half-lives tend to be alpha and beta emitters, making their handling easier, while those with short half-lives tend to emit the more penetrating gamma rays. Eventually all radioactive material decay into non-radioactive elements. **Table 7.3** provides a definition of the three types of radioactive decay, and describes the difference in penetrating power and biological effect of the different types of radiation.

Table 7.3: Types of radioactive decay.

Term	Description
Alpha activity.	Alpha activity takes the form of particles (helium nuclei comprising one proton and one neutron) ejected from a decaying (radioactive) atom. The particles have a very short range in air (typically about five centimetres). Alpha particles present in materials outside of the body are prevented from doing biological damage by the outer layer of skin cells, but can cause ionisation and damage in biological tissue if inhaled or swallowed.
Beta activity.	Beta activity takes the form of particles (electrons) emitted during radioactive decay from the nucleus of an atom. Beta particles cause ionisations in biological tissue which may lead to damage. Most beta particles can pass through the skin and penetrate the body, but a few millimetres of light materials, such as aluminium, would generally shield against them.
Gamma activity.	An electromagnetic radiation similar in some respects to visible light, but with higher energy. Gamma rays cause ionisations in biological tissue which may lead to damage. Gamma rays are very penetrating and are attenuated only by shields of metal or concrete depending on their energy. Their emission during radioactive decay is usually accompanied by particle emission (beta or alpha activity).

ii. Measurement of radioactivity and dose

7.3.5 There are three fundamental concepts that are important when considering radiation and its effects on physical objects:

- the actual radioactivity involved;
- the amount of energy the radiation imparts to other objects; and
- the biological effects of that radiation.

7.3.6 These concepts are behind the three units most commonly used to measure radiation. The radioactivity of a material is measured in becquerels; one becquerel is one decay per second from an object.

7.3.7 The amount of radiation absorbed by cells is measured in grays; one gray is one Joule of energy absorbed by 1kg of body mass. This is the dose received.

7.3.8 To measure the impact of radiation on people and the environment, the 'dose equivalent' in sieverts is measured.

7.3.9 **Chapter 25** of this volume sets out the legal, regulatory and advisory limits, and constraints on the level of radiation to which workers and the public can be exposed. Under the Nuclear Site Licence, SZC Co. would need to demonstrate that the proposed operating philosophy ensures that doses to operators, and the public, have been minimised so far as is reasonably practicable.

b) Radioactive waste

7.3.10 Any waste material contaminated with or incorporating radioactivity above certain prescribed thresholds, as set out in sections below, and for which no further use is envisaged, is designated as radioactive waste.

7.3.11 Radioactive waste is produced in the UK as a result of the generation of electricity in nuclear power stations, and from the associated production and processing of nuclear fuel, from the use of radioactive materials in industry, medicine and research, and from military nuclear programmes. Radioactive waste must be safely and appropriately managed in ways that pose no unacceptable risks to people, and to the environment. This requires a good understanding of the type and characteristics of the radioactive waste to be managed.

7.3.12 Waste processing systems would be in place to treat radioactive waste materials arising during operation and decommissioning of the Sizewell C power station, in order to reduce the activity of radioactive waste that is subsequently released to the environment such that it meets the conditions set out in the Radioactive Substances Regulations environmental permit granted by the Environment Agency.

7.3.13 The waste that is ultimately disposed of to the environment can be broadly grouped into three streams:

- gaseous waste discharged via stacks on the reactor buildings and other permitted outlets;
- liquid waste discharged via the liquid effluent discharge outlet; and
- solid waste that is treated and disposed of at permitted off-site facilities (this includes some wet solid waste, such as resins and sludges, which would be processed and disposed of as solid waste).

7.3.14 The management of solid radioactive waste depends, among other things, on its radioactivity level. In the UK, radioactive wastes are classified in terms of the nature, and quantity of radioactivity they contain, and the heat they produce. The categories are broadly divided into higher activity radioactive waste (higher activity waste), and lower activity radioactive waste.

i. Higher activity waste

7.3.15 Higher activity waste comprises:

- High Level Radioactive Waste: waste that is sufficiently radioactive for its decay heat to significantly increase its temperature and the temperature of its surroundings, such that heat generation has to be taken into account in the design of storage and disposal facilities.
- ILW: wastes exceeding the upper boundaries for LLW, but that do not require heat generation to be taken into account in the design of storage or disposal facilities.

7.3.16 The Higher activity waste definition also includes for any lower activity waste that does not conform to disposal requirements and therefore has to be managed as higher activity waste (note for the Sizewell C Project, no lower activity waste of this type has been identified).

ii. Lower activity waste

7.3.17 Lower activity waste comprises:

- LLW (Radioactive): waste that has a radioactive content not exceeding 4 giga becquerels per tonne of alpha activity, or 12 giga becquerels per tonne of beta/gamma activity.
- Very LLW (Radioactive): Very LLW is a sub-set of LLW with lower levels of radioactivity which enables its disposal to specific landfill sites that hold appropriate environmental permits.

c) Spent fuel

7.3.18 Spent fuel from nuclear power stations is not categorised as waste because it still contains uranium and plutonium which could potentially be separated out through reprocessing and used to make new fuel.

7.3.19 The 2008 Government White Paper, Meeting the Energy Challenge A White Paper on Nuclear Power Cm 7296 (Ref 7.21) concluded that:

> *“our view remains that in the absence of any proposals from industry, new nuclear power stations built in the UK should proceed on the basis that spent fuel will not be reprocessed. As a consequence, plans for waste management and financing should proceed on this basis”.*

7.3.20 Spent fuel is defined as "*nuclear fuel that has been irradiated in and permanently removed from a reactor core*". The long half-life of a proportion of the radionuclides contained within spent fuel, its level of activity (it produces heat for long periods), and its fissile content (it has the potential to be recycled and also raises security concerns) means that the management of spent fuel is an important issue for the design of any new nuclear power station. The characteristics of spent fuel mean that it is managed in a similar way to High Level Radioactive Waste, due to the high activity and heat generating characteristics

7.4 Sizewell C Integrated Waste Strategy

7.4.1 Strategic planning of radioactive waste management is a regulatory requirement and would be implemented for the Sizewell C Project through the development and production of an **Integrated Waste Strategy**. The **Integrated Waste Strategy** sets out the logic behind the development of individual waste strategies, and how their integration results in the effective management of all the radioactive wastes generated by Sizewell C. The **Integrated Waste Strategy** supports the Sizewell C Radioactive Substances Regulation environmental permit application (Ref. 7.23) to the Environment Agency.

7.4.2 The **Integrated Waste Strategy** aims to ensure that, during the construction, operation and decommissioning of the installation, workers, the public and the environment are protected and that radiation doses are ALARP. These objectives are achieved by minimising discharges of radioactivity to the environment through the application of the waste hierarchy and BAT. Definitions of ALARP and BAT are set out in **Table 7.4** below.

Table 7.4: Minimisation of dose, discharges, and radioactive waste.

Technique	Definition
ALARP	As Low as Reasonably Practicable is an expression used in risk reduction to define a standard or point at which the implementation of additional risk reduction measures would be grossly disproportionate to the benefits achieved.
BAT	Best Available Techniques describe the most effective economically and technically viable technology and methods designed to prevent, and where this is not practicable to reduce, emissions and their impacts on the environment as a whole.
Waste hierarchy.	This concept proposes that minimisation of the creation of waste is the best way to reduce waste, re-use the second-best option, followed by recovery (e.g. recycling) and as a last resort, disposal.

7.4.3 The key factors in demonstrating the minimisation of the production of radioactive waste are:

- Design of fuel, including containment – the fuel is designed and handled to retain as much of the actinides, and fission products as possible. This ensures that the radioactivity is removed with the fuel, and does not enter the primary circuit or cooling pond water. The fuel cladding material has been chosen due to its resistance to corrosion, its impermeability to fission and activation products, and the lower degree of activation. The manufacturing process minimises the presence of trace uranium on the outer surface which can release fission products into the primary circuit.

- Efficiency of fuel use – maximising the efficiency of fuel use, when coupled with fuel design and manufacture, will ensure that the minimum amount of spent fuel is created per unit of electricity generated. A combination of the UK European Pressurised Reactor (UK EPR^{TM}) core design, and the enrichment selected for the fuel is expected to deliver higher burn-up of the fuel which means that less fuel will be required. This will also reduce the secondary waste arisings from spent fuel management.

- Detection and management of failed fuel – the reactor is operated in such a way as to minimise the risk of fuel failure, and the subsequent transfer of actinides and fission products to the primary circuit. SZC Co. continuously reviews operational experience, and is engaged in exhaustive research and development programmes in this field. The condition of the fuel is assessed by monitoring the primary coolant activity levels. This allows any failures to be detected and managed.

- Materials of construction for the reactor and cooling circuits – the specification of any structural materials will include a requirement to replace or reduce those substances that are particularly susceptible to activation. This specification will also apply to materials that are susceptible to erosion, wear and corrosion so as to limit the potential for activation of any particulate matter that will pass through the reactor core with the primary coolant. Materials for the primary and secondary circuits will be specified to prevent leaks, to minimise the potential for corrosion and thus prevent the spread of radioactivity to lower contamination areas.

- Primary coolant chemistry – managing the primary coolant chemistry contributes to maintaining the integrity of the fuel cladding and the primary circuit by reducing corrosion. This, in turn, reduces the presence of activated corrosion products in the cooling circuit, and therefore minimises secondary waste from cooling water treatment. Chemistry management also includes the control of primary coolant gases, and helps to minimise the production of tritium. The coolant management system allows the chemistry to be modified to reflect specific requirements at different phases of reactor operation.

- Commissioning, start-up and shutdown procedures – a number of approaches have been developed to reduce the risk of generating corrosion products, which could subsequently become activated, during these key stages of reactor operation. Commissioning includes the creation of a tight and protective oxide layer on surfaces in the primary circuit. The primary circuit is degassed and purified during start-up to remove impurities that encourage corrosion. Cold shutdown procedures include a controlled release of corrosion products accumulated on surfaces. This allows them to be collected without the risk of activation in the neutron flux.

7.4.4 The features set out above will minimise the generation of radioactive waste and will, therefore, make a significant contribution to minimising the activity of the waste that will be discharged or disposed of.

7.4.5 SZC Co. has no plans to receive, process or store spent fuel or radioactive waste from other nuclear sites at Sizewell C power station. In addition, SZC Co. has no plans to reprocess spent fuel at Sizewell C power station, and has set out a baseline strategy that assumes interim storage followed by disposal. The facilities provided at Sizewell C power station have been designed and sized to manage, and store, the spent fuel and waste from the Sizewell C power station only.

7.5 High-level strategy for Sizewell C radioactive wastes

7.5.1 This section provides a description of SZC Co.'s proposal for the management of radioactive waste from Sizewell C power station. Any implemented options will ultimately depend on regulatory agreement with the Environment Agency and Office for Nuclear Regulation, and may therefore differ in some ways from those described within the following sections.

a) Solid radioactive waste and spent fuel management strategy

7.5.2 The strategy for solid radioactive wastes is that these are to be disposed of as soon as reasonably practicable where a viable disposal route is available. High Level Radioactive Waste, ILW and spent fuel for which there are as yet no available disposal routes would be accumulated and safely stored on-site in compliance with the requirements of the Nuclear Site Licence, and Radioactive Substances Regulations environmental permit until a suitable disposal route or an alternative management route becomes available.

7.5.3 The design of the UK EPR™ incorporates a number of measures aimed at minimising the amount of solid wastes by facilitating the segregation and volume reduction of solid wastes, taking account of the review of the performance and operating experience of existing reactors.

b) Liquid radioactive discharge strategy

7.5.4 The overall strategy for the management of liquid radioactive discharges which is presented in the Radioactive Substances Regulations Permit submission for Sizewell C (Ref. 7.23) is:

- minimising the production of liquid effluents at source;
- partitioning of radionuclides where appropriate to minimise the environmental risks and impacts;
- optimum use of segregation and effluent treatment systems to afford greatest flexibility in their management;
- abatement to capture, concentrate and contain radionuclides, where appropriate, through the use of demineralisation, evaporation and filtration. The treatment of liquid effluent will exclude where reasonably practicable entrained solids, gases and non-aqueous liquids from the discharges;
- optimum use of suitable storage systems for the site, taking advantage of any delay and radioactive decay that may arise;
- assessment and sentencing of liquid effluents prior to discharge to confirm that these are in line with permitted levels;
- where radioactive effluent is discharged into the environment, optimising the manner and timing of any release to minimise the impacts on the environment and members of the public; and
- carrying out routine surveys of the environment to establish that the impact is acceptable.

7.5.5 The management strategy to limit radioactive liquid discharges from the operating activities of the UK EPR^{TM} is based on the design of the plant, and the operational practices to be implemented.

7.5.6 The design features use BAT to minimise liquid discharges at source and to minimise the impacts of discharges by means of abatement and discharge plant. SZC Co. will balance worker doses, costs and the accumulation on-site of additional solid waste incurred as a result of treatment in the plant with any potential reduction in public doses from discharges. Systems and plant are managed and used in a manner so as to minimise, so far as reasonably practicable, the environmental impacts of discharges, and to ensure that all discharges are monitored and recorded to demonstrate that they fall within the permitted limits.

c) Gaseous radioactive discharge strategy

7.5.7 The overall strategy for the management of gaseous radioactive discharges presented in the Sizewell C Radioactive Substances Regulations Permit submission (Ref 7.23) is:

- minimising the production of gaseous effluents at source;
- partitioning of radionuclides, where appropriate, to minimise the environmental risks and impacts;
- abatement of gaseous discharge streams through the use of carbon delay beds to capture noble gases, carbon traps to capture isotopes of iodine and high efficiency particulate air filters to trap particulate activity;
- monitoring of gaseous effluent prior to discharge;
- where radioactivity is discharged into the environment ensuring the design of the stacks is optimised such that they minimise the impacts on the environment and members of the public; and
- carrying out an agreed environmental survey programme to confirm that off-site impacts are acceptably small.

7.5.8 As with liquid discharges, the management strategy to limit radioactive gaseous discharges from the operating activities of the UK EPR^{TM} is based on the design of the plant and the operational practices to be implemented. The design features use BAT to minimise gaseous discharges at source, and to minimise the impacts of discharges by means of abatement and discharge plant, and also balance worker doses and costs together with the accumulation on-site of additional solid waste incurred as a result of treatment in the plant with any potential reduction of public doses from discharges. Systems and plant are managed and used in a manner, so as to minimise so far as reasonably practicable, the environmental impacts of discharges, and to ensure all discharges are monitored and recorded to demonstrate that they fall within the permitted limits.

7.6 Radioactive waste during construction

7.6.1 As set out within **Chapter 15** of Sizewell B relocated facilities **ES** as provided in **Volume 1, Appendix 2A** of the **ES**, there is the potential for radioactive waste to be generated from the demolition of the existing Sizewell B outage store as part of the Sizewell B relocated facilities works. It is noted that it is only the demolition of the outage store that raises any radiological risks, as other Sizewell B buildings to be demolished have not previously been associated with any work activities or processes which have involved the handling or the production of radioactive items or material.

7.6.2 To ensure compliance with the Nuclear Site Licence, environmental permit and Ionising Radiations Regulations 2017, a radiological survey of the existing outage store will be undertaken by the Sizewell B Health Physics team to confirm, if any further measures are required prior to the start of demolition works. Existing general area surveys have shown no contamination of the area and, as such, only limited surveying is proposed to be carried out beforehand as a precautionary measure. If required following the radiological survey, a strategy would be developed to decontaminate and demolish the radioactive structures and determine how the radioactive waste would be managed, including suitable monitoring protocols. This strategy would be agreed in consultation with the Environment Agency prior to the start of demolition works. Waste from the works would be managed in compliance with the existing Sizewell B site and company procedures.

7.6.3 In addition, radioactive sources would be used to support geophysics and radiography during the construction of the Sizewell C power station. There is a legal requirement under the Ionising Radiation Regulations 2017 for Sizewell C to have procedures in place to control the use of radioactive sources. No other radioactive material would be used during construction. There is, therefore, no potential for radioactive waste to be generated during the construction of the Sizewell C power station.

7.6.4 It is not anticipated that residual radioactive materials from the existing Sizewell A and B power stations would be encountered in soils and sediments excavated during clearance and excavation activities, beyond those already reported in routine monitoring programmes. Monitoring activities undertaken and to be undertaken are covered in more detail in **Chapter 28** of this volume.

7.6.5 A rock and soil sampling survey across the main development site found concentrations of naturally occurring radionuclides typical of natural soils and rock. There was no evidence of elevated radionuclide concentrations above typical background for the local area as provided in **Chapter 18** of this volume.

7.6.6 Measurements of radioactivity in marine rock and sediment samples taken from the proposed location of the Beach Landing Facility show low levels similar to those observed in the routine monitoring programme around the existing Sizewell A and B power stations (Ref 7.2). **Chapter 21** of this volume covers marine sampling in more detail.

7.6.7 There is therefore no evidence of existing in-ground contamination arising from the existing Sizewell A and B power stations. Management of radioactive waste generated during the operation of the Sizewell C power station.

7.7 Radioactive waste arising during operation

a) Management of low level waste generated during the operation of the Sizewell C power station

7.7.1 The precise volume of solid LLW produced by Sizewell C power station is dependent on the future management of the various systems associated with the operation of the nuclear power station.

7.7.2 **Table 7.5** provides a description of the LLW that would be generated from the operation of the Sizewell C reactors and auxiliary facilities. These can be grouped in two broad categories:

- LLW generated through operation of systems and processes used to ensure safe operation of the power station or to minimise discharges of radioactivity to the environment; and
- LLW generated during maintenance and refuelling operations.

7.7.3 **Table 7.6** provides the annual estimated production of raw (untreated) LLW for two UK EPR™ units based on the information presented in the Sizewell C Radioactive Substances Regulations Permit submission (Ref 7.23). The volume and activity of LLW requiring disposal from Sizewell C would be minimised by the use of the waste hierarchy and the application of BAT.

Table 7.5: Categories of LLW that would be generated at Sizewell C power station.

Waste Type.	Waste Description.
Steam generator blowdown system ion-exchange resins.	Ion-exchange beds are utilised in the steam generator blowdown system to trap activation and fission products from the primary coolant circuit. In recycling the steam generator blowdown system blowdown water from the UK EPR™ secondary circuit, the blowdown water is purified by the use of two parallel filters for the removal of suspended solids and two parallel demineralisation lines which use ion-exchange resins to perform the demineralisation.
LLW wet sludge.	During the operation of the Sizewell C UK EPR™ units, particulates would settle as sludges in various buffer and storage tanks associated with the auxiliary water circuits (e.g. liquid waste processing system). These are likely to be contaminated with small quantities of fission and activated corrosion products. This sludge is periodically cleaned out and removed for treatment prior to disposal as LLW.

Waste Type.	Waste Description.
LLW cartridge filters from auxiliary circuit treatment.	Filters are used to capture particulate material in the UK EPR™ water auxiliary circuits. Spent filter cartridges arise from the treatment lines of the following water auxiliary circuits: Chemical and volumetric control system, boron recycle system, liquid waste treatment system, and the spent fuel storage compartment treatment system. Water filters are withdrawn from operation on the basis of clogging and/or dose rate and then treated as waste. The physical form of this waste stream consists of filter cartridges that are composed principally of stainless steel supports with glass fibre filter media and some organic materials. The amount of particulate radioactive material (principally metallic oxides) trapped on each filter can vary. The majority of waste within this category is anticipated to be ILW at the point of generation but some LLW is expected.
Evaporator concentrates.	The UK EPR™ proposes to make use of evaporation for the minimisation of non-recyclable radioactive liquid effluents arising from the liquid waste treatment system. Evaporation would be used to minimise the discharge of active aqueous effluents to the environment. Evaporation of effluents results in the production of a sludge-like concentrate that would contain the bulk of the radioactivity initially present in aqueous effluent streams as activated metal oxides.
Air filters.	All radiation controlled areas of the nuclear auxiliary building, fuel building, safeguards buildings, reactor building, operational production centre, access building and effluent treatment building are served by dedicated ventilation systems. The extract from these systems is subject to a number of airborne activity abatement techniques, including the use of high efficiency particulate air filtration, before discharge to the environment. The high efficiency particulate air filters remove particulate material to ensure doses to workers are ALARP and discharges to the environment are minimised. This also ensures that the doses to members of the public from airborne discharges are minimised. The abatement systems would produce a number of spent LLW high efficiency particulate air filters over the course of reactor operation.
Water filters.	Water filters may arise from filtering of the low active effluent (from the gaseous waste processing system, liquid waste treatment system, steam generator blowdown system). The physical form of this waste stream consists of filter cartridges that are composed principally of stainless-steel supports with glass fibre filter media and some organic materials. The amount of particulate radioactive material (principally metallic oxides) trapped on each filter can vary.
Dry active wastes.	Dry active wastes comprise the combustible and non-combustible LLW generated through routine and maintenance operations in the UK EPR™ Nuclear Island consists of contaminated personal protection equipment, monitoring swabs, plastic, clothing, contaminated tools, segregated pieces of metal, glassware and other process consumables. These wastes mainly arise during outages.
Oils and solvents.	Oils are used in the lubrication of various components such as circulators and process pumps and have the potential to become radiologically contaminated during normal service. Contaminated liquids such as chemical cleaning solutions and solvents used as decontamination agents also arise and would be included within this waste stream.
Metal scraps and other metallic wastes (Dose rate < 2 mSv/h).	Metal wastes arise during maintenance operations from the replacement of engineering components. The redundant metal components or equipment

Waste Type.	Waste Description.
	used during the maintenance operations in the nuclear island may become contaminated and require disposal as radioactive waste.

i. Arrangements for site low level waste management

7.7.4 Detailed arrangements for radioactive waste management would be covered in the SZC Co. operating procedures required to demonstrate compliance with Nuclear Site Licences and Radioactive Substances Regulations requirements. For LLW, these instructions are anticipated to cover minimisation, segregation, characterisation/assessment, packaging, labelling, record keeping and consignment for transfer/disposal.

ii. Facilities to be provided for site low level waste management

7.7.5 LLW generated during the operational period from both the reactors and the associated auxiliary plant would be transferred to the radioactive waste process building of Sizewell C reactor unit 1 (Unit 1). This facility is designed to manage waste through segregation and application of suitable treatments in preparation for disposal. LLW would be processed and packaged as required to meet the conditions for acceptance of the appropriate off-site disposal facility.

7.7.6 LLW would be safely transferred from different locations in the radiation controlled area to the radioactive waste process building. Waste would be collected and stored according to waste activity categorisation at dedicated locations in the radioactive waste process building, and placed into a temporary buffer store prior to treatment. The waste would then be separated on the basis of the treatment method, and would be stored in these areas until sufficient quantities have accumulated for a treatment campaign to start or for shipment off-site.

7.7.7 The treatment route for solid waste would be determined (once it has been monitored and assayed) by categorisation of the waste, and by considering its physical and chemical characteristics.

7.7.8 Once categorised, the waste would be packaged (and conditioned if necessary) and transferred off-site to the most appropriate facility for its treatment (such as super-compaction, metal treatment or incineration) or disposal.

iii. Segregation

7.7.9 Solid wastes would, as far as practicable, be segregated and sorted at source to minimise secondary handling. Where waste streams generate mixed wastes, these would be sorted in a dedicated unit within the radioactive waste process building to optimise their subsequent management and disposal. If no further benefit can be obtained from further segregation then the waste would be transferred to the next stage. The benefits associated with the segregation of waste need to be balanced with the detriments associated with increased operator exposure.

7.7.10 The segregation of the waste into different waste groups would be carried out on the basis of different physical and chemical properties, e.g. combustible, non-combustible and compactable waste, and non-compactable waste.

iv. Shredding

7.7.11 Bulky solid combustible and compactable waste may be size reduced by shredding in the radioactive waste process building prior to further treatment. The waste is size reduced by the use of a rotating blade assembly. The shredded material then falls through a duct into a compactable drum located directly below the shredder. Once full, the drum would be returned to the storage area and temporarily stored until a sufficient volume of waste for treatment or disposal is collected.

v. Low force compaction

7.7.12 A low force compactor in the radioactive waste process building could be used on-site to assist in the volume reduction of appropriate wastes prior to transfer off-site for disposal.

vi. Conditioning of low level waste for disposal

7.7.13 Some LLW, e.g. sludges and resin, may require processing within the radioactive waste process building through a combination of dewatering, drying, and encapsulation in a mortar matrix within the waste disposal package prior to transfer from the site in order to meet the conditions for acceptance for the proposed disposal site.

vii. Handling and transfer of final packages

7.7.14 Following treatment, the waste would be placed in an appropriate container for transport or disposal. After being sealed, the containers would be checked for the presence of external contamination prior to transfer out of the radioactive waste process building. Waste containers awaiting transfer off-site would be placed in buffer stores and transferred into transportation containers prior to loading onto the transportation vehicle.

viii. Low level waste volume estimates

7.7.15 The LLW volume estimate is based on a review of the waste arisings from existing French nuclear reactors of similar power rating to the UK EPR^{TM}, performed as part of the Generic Design Assessment (GDA) process. It is assumed at present that Sizewell C, with two UK EPR^{TM} units, would produce double the arisings predicted for one unit in the GDA, even though some facilities would be shared between the two UK EPR^{TM} units. The sharing of facilities, such as the waste treatment facilities, may result in some reduction of operational arisings. However, at this stage it is not possible to make precise predictions of reductions so the figures set out in **Table 7.6** are considered to present a best estimate of solid LLW arisings.

ix. Low level waste disposal strategy

7.7.16 A key consideration of the choice of preferred disposal route has been the commitment to demonstrate best use of existing UK LLW management assets. Therefore, direct disposal to LLW Repository, near Drigg in Cumbria, is seen as the least desirable option, and where a reasonably practicable alternative disposal route exists, e.g. incineration or metal recycling, this would be proposed as the preferred option. This approach is consistent with the national strategy for LLW as set out previously in **section 7.2** and SZC Co. will aim to utilise alternative disposal routes to the LLW Repository as available. This will contribute to the minimisation of the disposal of wastes to the LLW Repository, and maximise its remaining operational lifetime.

7.7.17 The strategy for LLW is that waste generated throughout the operation and decommissioning of Sizewell C power station would be disposed of as soon as reasonably practicable, following treatment to minimise volume and perform appropriate conditioning or packaging. The ultimate disposal of the wastes is expected to be via one of the following main routes depending on the radioactivity level of the waste produced, its physical characteristics and its chemical properties:

- off-site treatment of metals, ultimately for recycling, via commercially available routes subject to meeting the relevant conditions for acceptance;
- off-site incineration of combustible wastes using commercially available routes subject to meeting relevant conditions for acceptance. There would be no on-site incineration of wastes;
- use of an appropriate authorised off-site disposal facility for exempt and Very LLW disposal (notably for soil, rubble and aggregates) where no reuse or recycling options are viable, subject to meeting relevant conditions for acceptance;
- transfer of suitable LLW for super-compaction prior to disposal at the LLW Repository to minimise disposal volume; and
- disposal of LLW directly to LLW Repository would be utilised only where the above alternatives are not practicable.

7.7.18 For all LLW, acceptance for disposal has been agreed in principle with LLW Repository who provide access to each of the available radioactive waste treatment routes in the UK.

7.7.19 SZC Co. has reviewed the potential treatment and disposal options for LLW from Sizewell C. The preferred options for management of LLW generated at Sizewell are set out diagrammatically in **Plate 7.1** and summarised in **Table 7.6**.

7.7.20 SZC Co. is aware that the LLW Repository has a current estimated lifetime shorter than the operation of Sizewell C. It is assumed that, as stated in Government policy (Ref 7.4) and enshrined in Environmental Permitting Regulations 2016 (as amended), that new disposal facilities (either at LLW Repository or elsewhere) will ultimately be provided by the NDA after the current LLW Repository has ceased to receive waste. However, SZC Co. will apply the waste hierarchy and waste segregation to demonstrate best use of existing UK LLW management assets.

x. Off-site metal recycling facility operations

7.7.21 Where the metallic waste generated by operational maintenance work cannot be adequately decontaminated on-site, the waste would be transferred to an off-site commercial metal recycling facility. The volume of metallic waste requiring disposal could be reduced significantly using metal recycling techniques.

7.7.22 Once transferred to the metal recycling facility, a range of industrial cutting and cleaning techniques would be applied. The metallic waste is decontaminated and cleaned using methods such as dry grit blasting. The resulting materials can either be recycled in the UK, or potentially sent to a facility for further cleaning by melting.

xi. Off-site incineration operations

7.7.23 LLW would be segregated within the HQB to separate combustible waste from non-combustible. Combustible waste suitable for incineration would be transferred to an off-site commercial incinerator and incinerated in a specially engineered kiln up to around 1000^{o}C. Any gases produced during incineration are treated and filtered prior to discharge into the atmosphere and would conform to international standards and national emissions regulations.

7.7.24 Incineration of combustible wastes is used as a treatment for both radioactive and conventional wastes in the UK. In the case of radioactive waste, incineration has been used for the treatment of LLW from nuclear power plants, fuel production facilities, research centres (such as biomedical research), the medical sector and other waste treatment facilities.

7.7.25 Modern incineration systems are well engineered and designed to burn the waste efficiently whilst producing minimum emissions. Ash remaining following incineration would be disposed of as appropriate.

xii. Off-site super compaction facility operations

7.7.26 Suitable LLW would be transferred off-site to a super compaction facility to minimise its volume. In this process drums or boxes of waste are compacted under high pressure of up to 2,000 tonnes per square metre. Following super compaction, the drums would be transferred onward to LLW Repository, near Drigg, in Cumbria for disposal.

xiii. Low level waste repository operations

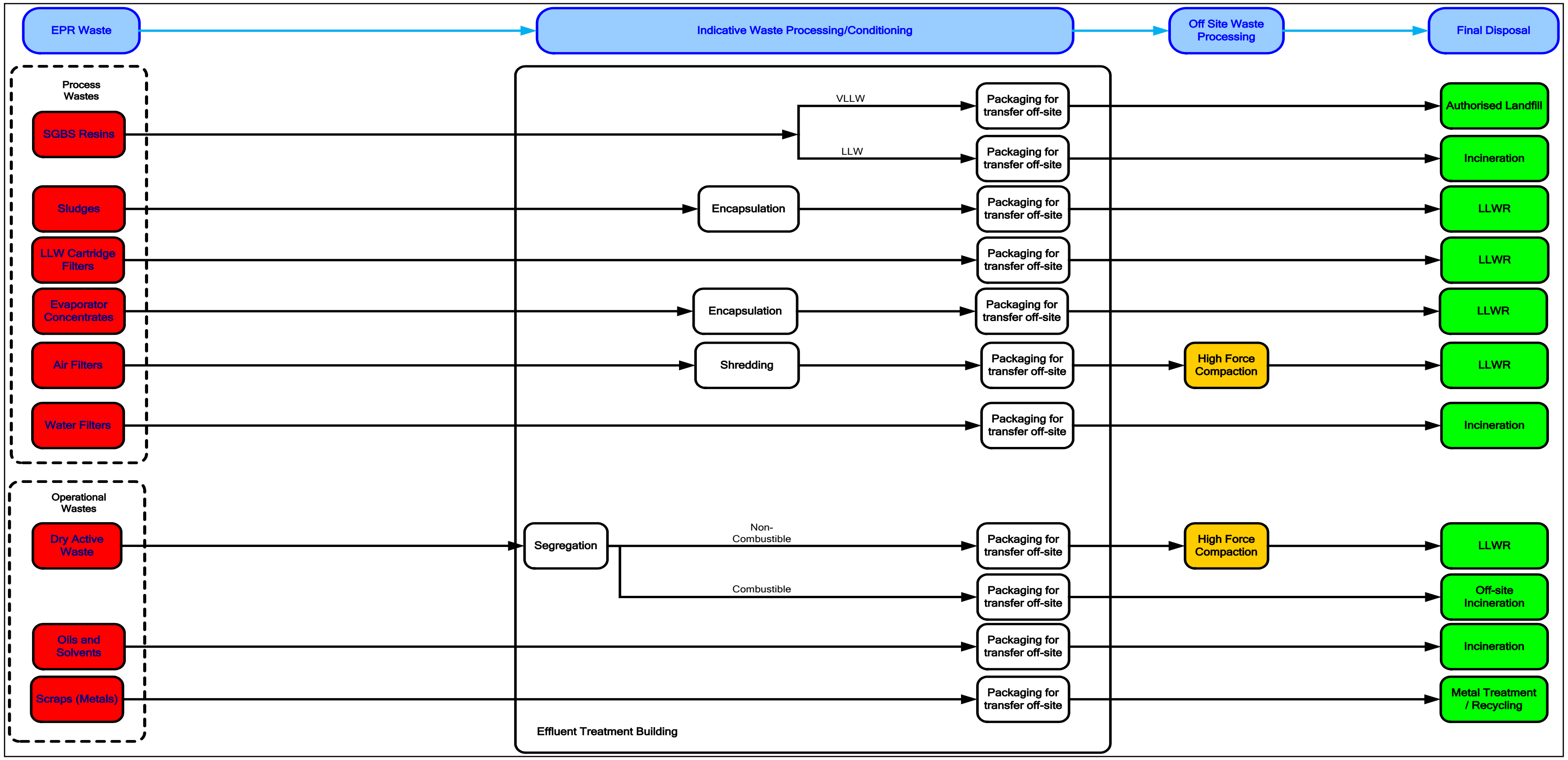
7.7.27 LLW unsuitable for disposal via the above disposal routes, but which meets the WAC for LLW Repository, would be packaged on-site and transferred directly for disposal to LLW Repository in approved transport packages e.g. Half Height ISO Containers.

xiv. Very low level waste operations

7.7.28 High-volume Very LLW could be disposed of too specifically approved landfill sites. The waste would be subject to controls on its disposal which would be specified by the Environment Agency.

7.7.29 Wastes from Sizewell C will be transferred to LLW disposal sites, only if they have been demonstrated to represent BAT for the disposal of the waste, and have been authorised by the UK regulatory bodies to accept the waste for disposal.

Plate 7.1: Indicative LLW processing and disposal strategy.



Note these disposal routes represent the preferred option for LLW management and disposal based on the anticipated waste characteristics. Alternative routes may be utilised in the future if they can be demonstrated to represent BAT or if the above disposal routes are found to be unavailable.

Table 7.6: LLW generation and proposed management strategy for the Sizewell C UK EPR™s (2 EPR™ units).

Waste Type.	Estimated Raw Waste Volume Annual from Two UK EPR™s cubic metres (m^3).	Preferred Waste Arrangement[1].	Alternative Waste Arrangement.
Steam Generator Blowdown System APG ion-exchange resins.	15	Package as required to meet conditions for acceptance and transfer for disposal as Very LLW.	Transfer for incineration. Direct disposal to LLW Repository.
Wet sludge (from sumps, tanks).	1	Condition/package as required to meet conditions for acceptance and transfer for disposal to LLW Repository.	
LLW cartridge filters from auxiliary circuit treatment.	0.10	Condition/package as required to meet conditions for acceptance and transfer for disposal to LLW Repository.	
Evaporator concentrates.	6	Condition/package as required to meet conditions for acceptance and transfer for disposal to LLW Repository.	
Air and water filters.	8	Direct disposal to LLW Repository (water filters). Transfer for high force compaction (air filters) and onward disposal to LLW Repository.	Direct disposal to LLW Repository.
Dry active wastes (excluding metals). Non-combustible	25	Transfer for high force compaction and onward disposal to LLW Repository.	Direct disposal to LLW Repository.

[1] Note these disposal routes represent the preferred option for LLW management and disposal based on the anticipated waste characteristics. Alternative routes may be utilised in the future if they can be demonstrated to represent BAT or if the above disposal routes are found to be unavailable.

Waste Type.		Estimated Raw Waste Volume Annual from Two UK EPR™s cubic metres (m^3).	Preferred Waste Arrangement[1].	Alternative Waste Arrangement.
	Combustible	75	Package and transfer for off-site incineration.	Direct disposal to LLW Repository.
Waste oils and solvents.		4	Package and transfer for off-site incineration.	
Metal scraps and metallic waste.		12	Package and transfer for metals treatment.	Direct disposal to LLW Repository.

xv. Transport arrangements for low level waste

7.7.30 All radioactive waste transferred from the site would need to comply with applicable UK and international legislation at the time of despatch, including the relevant requirements of the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (as amended). Each consignment would undergo the required contamination checks and external radiation measurements before leaving the site.

7.7.31 Radioactive waste is transported in specially designed and approved packages. The packages provide protection to operators and members of the public and are required to be sufficiently robust to withstand a wide range of credible accident scenarios.

xvi. Timing of the decommissioning of low level waste facilities

7.7.32 The LLW processing facilities would be utilised for the management of wastes throughout the operation of both of the Sizewell C UK EPR^{TM} units. It is anticipated that the LLW processing facilities would be decommissioned in the final stages of the main decommissioning phase as set out in **Chapter 5** of this volume.

b) Intermediate Level Waste and High Level Waste

i. Management of Intermediate level waste generated during operation of the Sizewell C power station

7.7.33 Routine operation of the Sizewell C reactor units and their associated auxiliary systems would generate ILW. The majority of ILW would arise from the treatment of liquids and gases in order to reduce worker doses and discharges of radioactivity to the environment, e.g. ion exchange resins.

7.7.34 In addition to the process wastes, operational wastes may be generated as a result of maintenance work carried out during reactor operation and work performed during reactor outages.

7.7.35 The ILW streams that are anticipated to arise from normal operation and maintenance of the two UK EPR™ reactor units at Sizewell C power station are set out in **Table 7.7** below.

Table 7.7: Categories of ILW that would be generated at Sizewell C.

Waste Type.	Waste Description.
ILW ion exchange resins.	Ion exchange beds are used to capture and minimise soluble radioactive material. This material results from corrosion in the primary circuit (mainly in the steam generators and activation of chemicals in the primary circuit) and in the following UK EPR^{TM} water auxiliary circuits: • chemical and volumetric control system; • coolant purification system; and • spent fuel storage compartment treatment system. The ion exchange resins in the beds are periodically changed to optimise their performance. Additional volumes of ILW ion exchange resins may arise from the maintenance of water quality and the abatement of liquid discharges from the Interim Spent Fuel Store (ISFS).
ILW cartridge filters.	This waste consists of filters used in the clean-up of primary circuit water and water from the liquid waste and spent fuel pool treatment systems. There are several designs of filters depending on the abatement required. A proportion of the filters generated would fall into the ILW category.
ILW sludges.	During the operation of the Sizewell C UK EPR^{TM} units, particulates would settle as sludges in storage tanks associated with the auxiliary water circuits e.g. liquid waste treatment system. These are variously contaminated with a range of fission and activated corrosion products. This sludge would be periodically cleaned out and removed for treatment prior to disposal. The waste is a sludge consisting of settled particulate. A proportion of the sludge generated would fall into the ILW category.
Operational wastes more than 2mSv/hr.	This comprises a range of materials including contaminated metal, plastics, cloth, glassware, and rubble arising from operations during planned shutdown periods. Activated components with higher dose rates generated during maintenance operations may be temporarily placed into the reactor fuel pools to allow for a period of radioactive decay in order to minimise dose to workers.

ii. Intermediate level waste management strategy for Sizewell C power station

7.7.36 The strategy is for ILW to be retrieved, conditioned and packaged on-site on a campaign basis throughout the operational phase. Waste processing would result in a passively safe package ready for interim storage. The passively safe packages would be stored in the ILW interim storage facility for the duration of operations. The stored ILW packages would be removed from the ILW store when a Geological Disposal Facility is available to accept new build waste for final disposal. The assumed timescales for store emptying are discussed later in this chapter.

iii. Decay storage of waste for re-categorisation

7.7.37 The process of waiting for a natural decline in the level of radioactivity to allow waste to be disposed of as a lower category of waste is known as decay storage.

7.7.38 The radioactivity of a proportion of the ILW that would be generated during operation of the Sizewell C UK EPR^{TM} units would be dominated at the time of arising by relatively short-lived radionuclides including cobalt-60 (half-life of 5.27 years), caesium-137 (half-life of 30.2 years) and iron-55 (half-life of 2.7 years).

7.7.39 Waste identified as being suitable for decay storage will be packaged into suitably robust containers within the radioactive waste process building, and transferred into the ILW interim storage facility for a period of storage. Following the period of interim storage, the radioactivity of the selected wastes would have reduced to such levels that the waste would no longer be classified as ILW. This waste would be removed from the ILW interim storage facility and managed as LLW.

iv. Disposability of intermediate level waste from Sizewell C

7.7.40 Before conditioning and packaging of ILW, there is a requirement for sites to produce an ILW packaging proposal. This would include a demonstration that, following conditioning, the waste would be compatible with existing or future planned management and disposal options. This requires that a letter of compliance is obtained for the packaging proposal.

7.7.41 The letter of compliance process is the mechanism that Radioactive Waste Management Ltd, discussed in **section 7.2**, uses to provide confidence that a waste package can be accepted at a future Geological Disposal Facility. The overall objective of the letter of compliance assessment process is to give confidence to all stakeholders that the future management of ILW packages has been taken into account as an integral part of their development and manufacture. This is achieved by the site operator working with Radioactive Waste Management Ltd to demonstrate that the waste packages produced by a proposed packaging process is compliant with the generic waste package specification and compatible with plans for transportation and emplacement in the planned future Geological Disposal Facility.

7.7.42 In cases, where the assessment has concluded that the waste package is compliant with the repository concept and underpinning assessments, Radioactive Waste Management Ltd confirms this by the issue of a letter of compliance.

7.7.43 As part of the GDA process, the opinion of Radioactive Waste Management Ltd was sought on the likely acceptability for disposal in a Geological Disposal Facility of packaged ILW generated by the UK EPR™. Radioactive Waste Management Ltd was asked for its views on a number of different waste packages, including those that would be produced by implementing the GDA reference strategy for on-site ILW management. Radioactive Waste Management Ltd indicated that, in principle, any of the proposed waste packages would be acceptable for disposal (Ref 7.5). SZC Co. will continue to work with Radioactive Waste Management Ltd through the letter of compliance process to ensure that packaged ILW from Sizewell C would be acceptable for disposal in a Geological Disposal Facility.

v. Sizewell C intermediate level waste processing strategy

7.7.44 The proposed strategy for ILW conditioning and packaging at Sizewell C assumes that operational ILW will be conditioned and treated using similar procedures as applied during the operation of existing Pressurised Water Reactors (PWRs) in SZC Co.'s French fleet, with due consideration of UK specific requirements.

7.7.45 ILW will be packaged into two types of container, a cylindrical pre-cast concrete cask and a stainless steel 500 litre (L) drum. The pre-cast concrete cask is to be utilised for ILW ion exchange resin. All other operational ILW waste streams will be packaged into the 500L stainless steel drum. The operational ILW will be conditioned within the container with the exception of dry active wastes, which will be stored un-conditioned to facilitate application of the waste hierarchy following decay. The packages of ILW will then be placed into the on-site ILW interim storage facility until a UK Geological Disposal Facility is available.

vi. Arrangements for site intermediate level waste management

7.7.46 Arrangements and requirements for radioactive waste management cover minimisation, segregation, quantitative assessment, packaging, labelling, record keeping and consignment for transfer/disposal. Processes will be established and implemented for the packaging of radioactive wastes and these arrangements will be reviewed periodically and adequate records maintained in compliance with the requirements of the Radioactive Substances Regulations permit and Nuclear Site Licence.

7.7.47 Processes would be established and implemented for the packaging of radioactive wastes that encompass the whole lifetime of waste packages to ensure that packaged waste has the properties ascribed to it. These arrangements would be reviewed periodically and adequate records maintained.

7.7.48 The management arrangements would apply to all activities, interactions and aspects that can affect the quality of the waste package product, including:

- waste characterisation;
- container design;
- container manufacture;
- wasteform development;
- process development;
- plant specification and design;
- letter of compliance submissions and advice actions;
- plant commissioning and operation;
- raw materials storage;
- waste package interim storage and monitoring;
- control of non-conforming packages;
- change control and continual improvement of waste package design, processing plant and interim storage; and
- package records and their long-term retention.

vii. Facilities for site intermediate level waste management

7.7.49 ILW generated on the Sizewell C power station site would require conditioning and packaging into an acceptable (passively safe) form prior to interim storage. This process is described in the following sections.

viii. Intermediate level waste processing and packaging

Intermediate level waste cementation

7.7.50 Cementation through the use of specially formulated grouts provides a means to immobilise radioactive material that is either solid or in various forms of sludges. At Sizewell C, it is anticipated that all ILW wastes, other than ion-exchange resins, would be conditioned utilising a cementation process.

7.7.51 In general, the solid wastes would be placed into 500L drums. The grout is then added into this container and allowed to set. The container with the now monolithic block of concrete/waste is then suitable for storage and disposal.

7.7.52 Similarly, in the case of sludges the current packaging assumption is that the waste would be placed in a 500L drum and a grouting mix, in powder form, is added. The two are mixed inside the container and left to set leaving a similar type of product as in the case of solids, which can be disposed of in a similar way.

Intermediate level waste Epoxy resin encapsulation

7.7.53 Ion-exchange resins consist of small beads used to remove radioactivity from contaminated liquids. The radioactive ions in the liquid are absorbed onto the resin by the chemical process of ion exchange. The resins retain the activity and the cleaned liquids can then be safely disposed of. When the ability of the resins to absorb more radioactive ions is exhausted, they become radioactive waste.

7.7.54 It is proposed that spent ion exchange resins would be processed by in-container solidification utilising a polymer solidification process. The process is already established as a technique for treating ILW ion exchange resins in the UK at the Magnox site at Trawsfynyyd. At Sizewell C, New Nuclear Build GenCo propose to utilise the same mobile processing units currently operating to manage the resin waste generated on the fleet of SZC Co.'s Nuclear Power Plants in France.

ix. Summary of intermediate level waste strategy and volumes

7.7.55 The processing strategy for the Sizewell C ILW streams is summarised in **Table 7.8**. The raw waste volumes set out in **Table 7.8** provide an upper estimate which does not take into account ILW that would, following decay storage in the ILW interim storage facility, be suitable for re-categorisation as LLW.

Table 7.8: Operational ILW waste generation and proposed management strategy for the Sizewell C UK EPR™ reactor units.

ILW Stream.	Waste Description.	Anticipated Annual Raw Waste Volume from two UK EPR™ reactor units (m^3).	Lifetime (60yr) Raw Waste Volume from two UK EPR™ reactor units (m^3).	Sizewell C Processing Strategy.
ILW ion exchange resins.	Organic resins that arise from the clean-up of primary circuit water, water from the effluent treatment systems and the reactor fuel pools.	6	360	Polymer immobilisation in concrete C1 casks. Followed by interim storage on-site awaiting availability of a Geological Disposal Facility.
ILW spent cartridge filters.	Filters from the clean-up of primary circuit water and water from the liquid waste and spent fuel treatment systems. The filters consist of a stainless-steel support, with a glass fibre or organic filter media.	10	600	Cement grouted in 500L drums. Followed by interim storage on-site awaiting availability of a Geological Disposal Facility. A proportion of this waste is anticipated to decay to LLW.
Operational wastes >2mSv/hr.	A range of materials, including activated core components, contaminated metal, plastics, cloth, glassware and rubble arising from operations during planned shutdown periods.	2	120	Placed into 500L drums. Decay stored until the waste can be managed as LLW. It is anticipated that all ILW dry active wastes will decay to LLW during the life of the station.
ILW wet sludge.	Sludge arising from cleaning the bottoms of liquid waste treatment tanks and various sumps.	2	120	Cement grouted into a 500L drum followed by decay storage until the waste can be managed as LLW. It is anticipated that all active sludge will decay to LLW during the life of the station.
Totals		**20m^3**	**1,200m^3**	

x. Non fuel core components

7.7.56 Various non-fuel core components, including rod cluster control assemblies; thimble plug assemblies; primary (neutron) source assemblies; and secondary (neutron) source assemblies, are anticipated to be in part ILW. They will be co-stored with spent fuel.

7.7.57 There is potential that some core instrumentation, such as self-powered neutron detectors, will be in part High Level Radioactive Waste, and that they will require management during operation. If this is the case, they will be transferred into the spent fuel pool and either left in the pool until decommissioning or packaged into something similar to the spent fuel dry storage cask with the Spent Fuel Store as seen in Section 7.7 d).

xi. Interim on-site storage of intermediate level waste

7.7.58 There is currently no ILW disposal facility in the UK. The Geological Disposal Facility is not expected to be available for disposal of wastes for a number of years after the Sizewell C power station starts operation. The strategy for ILW management at Sizewell C is, therefore, to process and store the waste on-site, according to the principles of passive safety pending availability of the Geological Disposal Facility.

7.7.59 The key requirement of the ILW interim storage facility would be to provide protection for the waste packages from potential degradation which could have a long-term impact on the integrity of the package and eventual acceptance of the package at Geological Disposal Facility. In terms of containment of radioactivity and prevention of releases which could impact upon the outside environment, a number of barriers and environmental controls are provided as listed below:

- the conditioned wasteform is the primary barrier, e.g. the cemented matrix;
- the waste container is the secondary barrier, e.g. the concrete package;
- control of the store environment is important in maintaining integrity of the waste container to ensure compliance with letter of compliance requirements, e.g. humidity levels controlled by adequate ventilation; and
- the store structure is the final layer of weather protection for the waste package and also provides a role in the physical security of the waste.

7.7.60 The store would require appropriate maintenance and various levels of in-service refurbishment. As a condition of the Nuclear Site Licences, the facilities on-site, including the ILW interim storage facility, would be subject to periodic review of the safety case throughout the operational life of the store, ensuring any necessary improvements would be made in a timely manner.

7.7.61 There will be capacity to receive and store packages of ILW waste arising from the planned 60 years of operation of the two UK EPR^{TM} units on the Sizewell C site. The waste would be packaged into a passively safe state as described earlier, prior to being transferred to the ILW interim storage facility.

7.7.62 The design and operation of the facility would be required to be compliant with the Nuclear Site Licences, and Radioactive Substances Regulations environmental permit with regard to the safety of workers, public and the impact on the environment. The facility would be designed, constructed and operated to comply with the Ionising Radiation Regulations 2017. The design of the facility would ensure doses to workers and the public would be minimised as far as reasonably practicable.

c) Facility design description

7.7.63 The ILW interim storage facility would consist of areas performing the following functions:

- receipt and dispatch area;
- interim storage space for all operational ILW until a Geological Disposal Facility becomes available;
- package inspection area; and
- facilities to manage ILW that would become LLW following a period of decay storage.

7.7.64 The facility would also require a number of auxiliary systems and plant, such as those providing electrical power, ventilation and maintenance facilities.

i. Long term management of intermediate level waste

Transport of intermediate level waste to Geological Disposal Facility

7.7.65 At the end of the interim storage period, it is the responsibility of the waste producer to ensure that the package is safe for export off-site and is compliant with transport regulations in force at that time. Assessments for the letter of compliance process also address transportation, so that transport issues will necessarily have been addressed for packages that comply with a letter of compliance.

7.7.66 All radioactive waste despatched from the site would need to comply with applicable UK and international legislation at the time of despatch, including the relevant requirements of the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (as amended), or equivalent. Each consignment would undergo the required contamination monitoring and external radiation measurements before leaving the site.

7.7.67 Radioactive waste is transported in specially designed and approved packages. The packages provide protection to operators and members of the public, and are required to be sufficiently robust to withstand a range of credible accident scenarios. The UK has more than 50 years of experience of transporting radioactive waste and other radioactive materials by road, rail and sea in accordance with international and national regulations that are designed to protect people, property and the environment. The transport of radioactive material and waste is a mature process that has a proven safety record.

Disposal of intermediate level waste to Geological Disposal Facility

7.7.68 For the purposes of decommissioning planning, it is assumed that the Geological Disposal Facility scheduling can be optimised to allow transfer of packaged ILW from the ILW interim storage facility during the main development site decommissioning phase. However, if optimisation requires a further period of interim storage, it is possible that the ILW interim storage facility may need refurbishment to extend its life until the Geological Disposal Facility is available. Safety issues related to the design of the ILW interim storage facility, and the extension of its life would be regulated outside of the planning regime, through nuclear site licensing.

7.7.69 The concrete packages and stainless steel 500L drums that will be utilised at Sizewell C have been successfully certified as a Type 2 Industrial Package for similar waste streams to those anticipated at Sizewell C. SZC Co. therefore deems this as a viable off-site transport option. An alternative could be to transport the packages in an appropriate overpack.

7.7.70 The potential impact of the disposal of UK EPR™ operational and decommissioning ILW on the size of a Geological Disposal Facility has been assessed by Radioactive Waste Management Ltd. Although the impact depends to some extent on the type of package, it has been concluded that in all cases the volume increase is relatively small, corresponding to less than approximately 60 metres (m) of disposal vault length for each UK EPR™. This represents less than 1% of the area required for the UK legacy ILW, per reactor. This reflects a substantial reduction in waste arising per unit of electricity generated in the UK EPR™ compared with earlier generations of the PWRs.

d) Spent fuel

i. Requirements for the management of spent fuel generated during the operation of Sizewell C UK EPR™

7.7.71 The UK EPR™ core contains the nuclear fuel in which the fission reaction occurs. The remainder of the core structure serves either to support the fuel, control the chain reaction or to channel the primary coolant.

7.7.72 The reactor core of a UK EPR™ consists of 241 fuel assemblies providing a controlled fission reaction and a heat source for electrical power production. Each fuel assembly is formed by a 17×17 array of Zircaloy M5 (or equivalent zirconium alloy) tubes, made up of 265 fuel rods and 24 guide thimbles. The fuel rods consist of uranium dioxide pellets stacked in a zirconium alloy cladding tube which is then plugged and seal welded.

7.7.73 It is currently assumed that a maximum of 90 spent fuel assemblies would be removed every 18 months of operation from each UK EPR™ unit. With time included for planned outages for maintenance over the anticipated 60 years operation, a total of approximately 3,400 assemblies per UK EPR™ unit are expected to be generated. Through the lifetime of Sizewell C power station, which would have two UK EPR™ units, a total of around 6,800 fuel assemblies would be generated. However, in order to ensure suitable contingency is in place the design of the interim store is sized for 7378 fuel assemblies (3689 per unit).

7.7.74 The dimensions of one fuel assembly are 0.214 metres (m) x 0.214m x 4.859m so the raw waste volume associated with the lifetime total of 6,800 fuel assemblies requiring interim on-site storage would be 1,513 m^3. Each spent fuel assembly has a mass of 527.5 kg of uranium; therefore, a total inventory at end of generation would be approximately 3,900 tonnes.

7.7.75 The 2008 Government White Paper, Meeting the Energy Challenge A White Paper on Nuclear Power (Ref. 7.21) concluded that any new nuclear power stations that might be built in the UK should proceed on the basis that spent fuel would not be reprocessed and that plans for, and financing of, waste management should proceed on this basis.

7.7.76 Whilst there is a Government programme in place to develop a Geological Disposal Facility, there is currently no disposal facility for spent fuel and the Geological Disposal Facility is not expected to be available when Sizewell C starts generating spent fuel. The strategy for spent fuel management at Sizewell C is, therefore, to store the spent fuel on-site pending availability of a Geological Disposal Facility. Although it is possible that over the life of the Sizewell C power station alternative facilities could become available that might allow spent fuel to be transported off-site earlier, it is prudent to plan on the basis that sufficient capacity is provided on-site to store the lifetime arisings of spent fuel from the two UK EPR™ units.

7.7.77 In addition, heat generated from radioactive decay means that spent fuel removed from a reactor must be cooled for an initial period before it can be placed into interim storage and eventually transported off-site for disposal.

7.7.78 The high level of radioactivity concentrated within spent fuel results in a significant level of heat being produced. This characteristic makes a period of interim storage, during which the level of heat production reduces, an important element of spent fuel management ahead of its eventual disposal.

ii. Arrangements for site spent fuel management

7.7.79 At each UK EPR™ unit at Sizewell C, fuel assemblies removed from the reactor would be cooled underwater in an on-site reactor fuel pool for up to 10 years. The reactor fuel pools are not designed for the full life-time arisings of spent fuel.

7.7.80 Following this initial storage period in the on-site reactor fuel pool, the spent fuel assemblies would be prepared for transfer to the separate on-site ISFS, where they would be safely stored until a Geological Disposal Facility is available for transfer, and the spent fuel is suitable for final disposal.

iii. Spent fuel interim storage at Sizewell C

7.7.81 The ISFS would provide storage for spent fuel from the Sizewell C UK EPR™ reactor units from around 10 years after the start-up of Unit 1 until the spent fuel is transferred off-site for disposal at the Geological Disposal Facility. The ISFS would be designed such that it can store spent fuel for up to 120 years. This would allow interim storage to be maintained until a Geological Disposal Facility, or an alternative disposal/management route, has been established and the heat levels within the fuel are at levels that permit its disposal.

7.7.82 The design of the ISFS must be capable of meeting the following requirements:

- to ensure safe operations (e.g. by preventing a criticality incident and maintaining effective containment);
- to provide radiological protection to the public, workers and the environment at all times in compliance with dose limits and ensuring that all doses are ALARP and discharges to the environment are demonstrated to be minimised in accordance with BAT;
- to ensure cooling to maintain spent fuel integrity; and

- to maintain spent fuel in a condition appropriate for transport and final disposal.

7.7.83 SZC Co. has reviewed the options available for on-site interim storage of spent fuel and determined that for the site-specific circumstances at Sizewell C, dry interim storage is the preferred approach.

7.7.84 Dry storage of spent fuel has been used widely and previously licensed in the UK and internationally. It is considered to be both safe and environmentally acceptable for use in the UK for spent fuel generated from the operation of Sizewell C. The use of dry interim storage of spent fuel is capable of providing Sizewell C with a safe, secure and technically flexible solution until such time that the spent fuel is suitable for transfer to a UK Geological Disposal Facility, or other off-site management facility.

7.7.85 The design and operation of the facility would be required to be compliant with the Nuclear Site Licences, and Radioactive Substances Regulations environmental permit with regard to the safety of workers, public and the impact on the environment. The facility would be designed, constructed and operated to comply with the Ionising Radiation Regulations 2017, ensuring doses to workers and the public would be minimised as far as reasonably practicable.

iv. Facilities for on-site spent fuel storage

7.7.86 The Sizewell C ISFS can be broken down into a number of functional processes:

- Fuel will be removed from reactor fuel pond and packaged into a canister within a transfer cask for transfer to the ISFS.
- On arrival at the ISFS the canister is removed from the transfer cask and loaded into a storage shelter.
- Reversal of the entire packaging process should physical inspection of the fuel assemblies be deemed necessary. It is currently assumed that an inspection facility will be constructed just prior to the end of generation to allow for the continued inspection of spent fuel in the absence of the fuel building.
- At the end of interim storage, the spent fuel assemblies will be transferred to a packaging plant to allow disposal to a Geological Disposal Facility. It is currently assumed that the inspection facility would be expanded to carry out the repackaging.

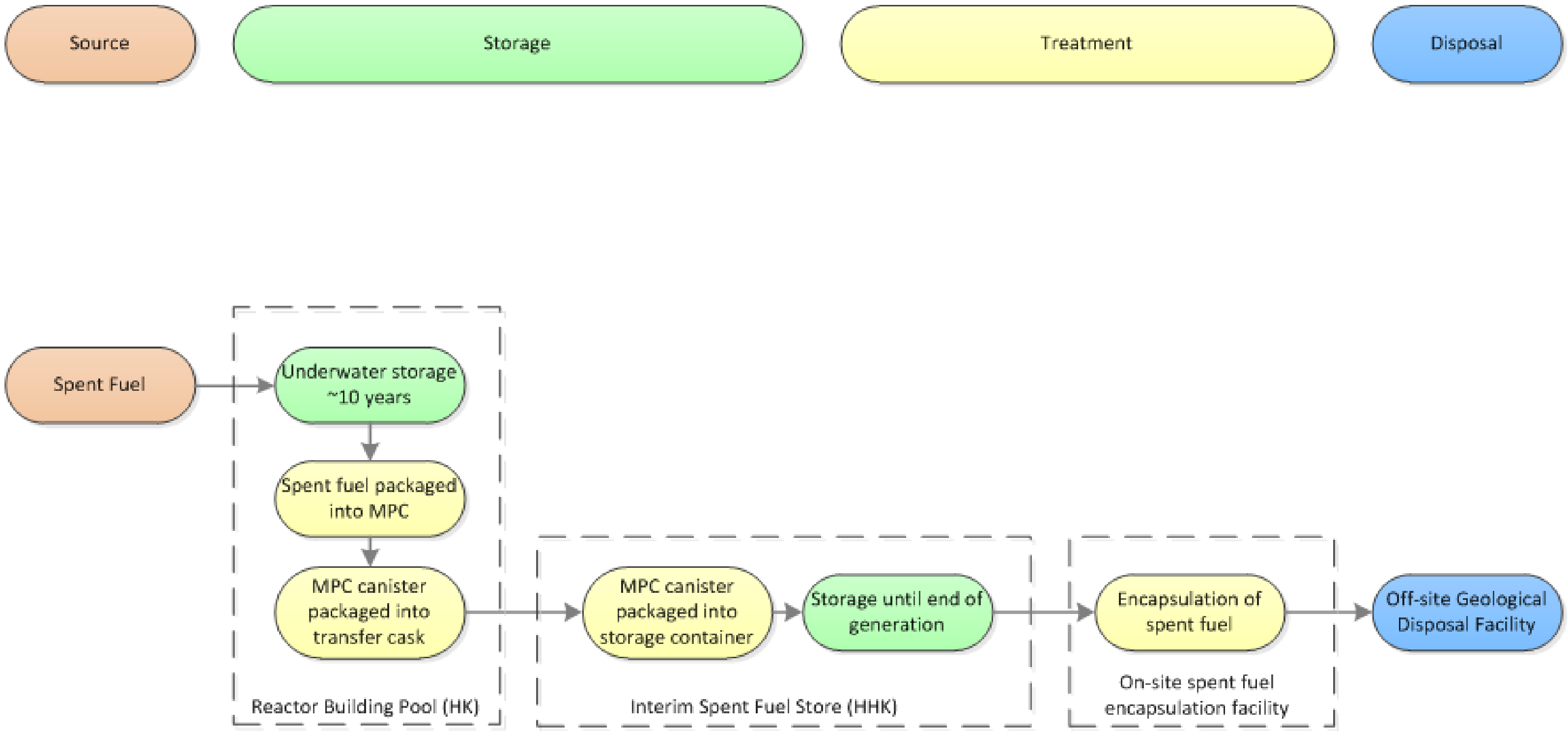
7.7.87 Spent fuel would not be placed into storage within the ISFS until several years after the start of generation.

v. Spent fuel management following reactor decommissioning

7.7.88 At the end of generation, all remaining spent fuel would be removed from the reactors and transferred to the ISFS, following the initial cooling period in the reactor storage pools. During the main site decommissioning phase, spent fuel would continue to be stored in the on-site ISFS and the store would be modified to allow it to function as a standalone facility after the rest of the site has been decommissioned.

7.7.89 Once the main Sizewell C power station buildings have been decommissioned, spent fuel will remain within the ISFS, and the facility will continue to be licensed as a nuclear site. A number of additional facilities would be provided to accommodate the requirements for a small workforce to operate the storage facility, ensure security of the site, and continue to maintain all safety and environmental obligations. The costs for these modifications and the continued operation of the facility would be funded through the SZC Co. FDP. Only when all the spent fuel has been removed from the ISFS, and decommissioning of the facility is completed, would this remaining part of the site be de-licensed and the land released for alternative use.

Plate 7.2: Sizewell C Spent fuel management strategy.



vi. Timing of transfer of spent fuel to Geological Disposal Facility

7.7.90 The time that would be required for the safe and secure on-site interim storage of spent fuel prior to disposal depends on two key factors:

- the availability of a Geological Disposal Facility; and
- the requirement that spent fuel characteristics are suitable to allow disposal to the Geological Disposal Facility (i.e. the spent fuel has sufficiently cooled to allow disposal to Geological Disposal Facility).

7.7.91 With regard to the availability of a Geological Disposal Facility, Radioactive Waste Management Ltd have published their plans for the scheduling and implementation of the Geological Disposal Facility (Ref 7.6) which provides a timeline that schedules the end of legacy spent fuel disposal to Geological Disposal Facility by 2130. Thereafter the Geological Disposal Facility could be available to dispose of spent fuel from Sizewell C.

7.7.92 Regarding disposability of spent fuel, work undertaken by Radioactive Waste Management Ltd on behalf of the Nuclear Industry Association (Ref 7.24) has concluded that the spent fuel from the UK EPR^{TM} could be suitable for disposal 55 years following the end of generation. It is therefore assumed that the date for start of transfer of spent fuel from the Sizewell C site to a Geological Disposal Facility is 55 years after the end of generation. The process of transfer from the site will take approximately eight and a half years. On completion of transfer of the spent fuel from site, the spent fuel ISF would be decommissioned. The final stage of decommissioning would be to demonstrate that there is no longer any danger from radioactivity on the site, and that it can therefore be de-licensed and the operator's period of responsibility brought to an end.

vii. Alternative scenarios for long-term interim storage of spent fuel

7.7.93 Whilst the strategy above represents the worst case for the purposes of the Environmental Impact Assessment, there are a number of alternative scenarios which could result in spent fuel being transferred from the site significantly earlier, allowing earlier decommissioning of the ISFS and subsequent site de-licensing. For example:

- a change in spent fuel management strategy, for example the provision of a UK centralised spent fuel interim storage facility; or
- the optimisation of the Geological Disposal Facility design to allow earlier disposal of new build spent fuel.

viii. Packaging (encapsulation) of spent fuel for disposal

7.7.94 The Radioactive Waste Management Ltd disposal concept for High Level Radioactive Waste and spent fuel is based on the Swedish KBS-3V method. Under this concept, spent fuel will be over-packed before disposal into durable, corrosion resistant disposal canisters, which will provide long term containment for the radionuclides contained within the spent fuel after disposal. This process is known as encapsulation and will be carried out in an encapsulation facility.

7.7.95 The location of the encapsulation facility is conservatively assumed for liability estimation purposes to be located on the Sizewell C site in close proximity to the ISFS. Other options, such as a national shared facility, are also being considered and the final decision is likely to be influenced by the outcome of the ongoing Geological Disposal Facility site selection process. The encapsulation facility would require separate planning consent from the proposed development, be subject to its own Article 37 submission under the Euratom Treaty, and would be designed, constructed and operated in compliance with the nuclear site licensing and environmental permitting requirements with regard to safety and radioactive waste discharges.

7.7.96 The transfer of the spent fuel assemblies within their canisters to the on-site encapsulation facility would be performed using the same or equivalent transfer casks used to transfer the fuel into storage.

ix. Transport and disposal of spent fuel to Geological Disposal Facility

7.7.97 As part of the GDA of the UK EPR™, Radioactive Waste Management Ltd has undertaken a Disposability Assessment for the spent fuel expected to arise from the operation of a UK EPR™. This assessed the implications of the disposal of the proposed spent fuel disposal packages against the waste package standards and specifications developed by Radioactive Waste Management Ltd and the supporting safety assessments for a Geological Disposal Facility. The safety of transport operations, handling and emplacement at a Geological Disposal Facility, and the longer-term performance of the system have been considered, together with the implications for the size and design of a Geological Disposal Facility.

7.7.98 On the basis of the GDA Disposability Assessment for the UK EPR™, Radioactive Waste Management Ltd has concluded that, compared with existing spent fuel, no new issues arise that challenge the fundamental disposability of the spent fuel expected from the operation of such a reactor. This conclusion is supported by the similarity of the fuel to that expected to arise from the existing PWR at Sizewell B. Given the availability of a disposal site with suitable characteristics, the spent fuel from the UK EPR™ is expected to be disposable.

7.7.99 The assumed operating scenario for a single UK EPR™ reactor unit (60 years operation) gives rise to an estimated 900 disposal canisters. This has been calculated to require an area below ground of approximately 0.15 kilometres squared (km^2) for the associated disposal tunnels representing approximately 8% of the area required for legacy High Level Radioactive Waste and spent fuel. The spent fuel associated with the two Sizewell C UK EPR™ reactor units would require an area of approximately $0.3km^2$, excluding associated service facilities. This represents approximately 16% of the area required for legacy High Level Radioactive Waste and spent fuel.

7.8 Additional information on likely effects

a) Low level waste management activities

7.8.1 The likely effects associated with LLW management activities proposed at Sizewell C have been considered as part of the relevant construction and operational assessments presented within this volume of the ES. **Table 7.9** identifies where the construction, operation and decommissioning of LLW management facilities are addressed.

Table 7.9: Location of further information on LLW management activities.

Activity	Description	Chapter
Processing of LLW for off-site transfer.	The processing of LLW in preparation for off-site transfer and disposal would take place within purpose-built facilities. These processes would result in very small discharges of radioactivity. The potential impacts of Sizewell C radiological discharges are considered within the 'Radiological' **chapter 25** of this volume.	**Chapter 25** of this volume.
Storage of LLW.	The temporary storage of LLW on the site prior to transfer for treatment or disposal would have minimal impact on off-site dose from direct radiation or from discharges due to the very low specific activity of the waste and the controls that would be in place. The implications of direct dose from Sizewell C are considered in the 'Radiological' chapter of this volume.	**Chapter 25** of this volume.
Construction of LLW management facilities.	The construction of buildings associated with LLW management would be part of the main development site construction activities, which are presented within the 'Description of Construction' chapter of this volume.	**Chapter 3** of this volume.
Transport of LLW to off-site disposal facilities.	Transport of LLW from Sizewell C for off-site disposal or treatment would be anticipated to result in a small number of additional annual Heavy Goods Vehicle (HGV) movements from the site to the disposal/transfer facilities. These movements have been accounted for within the operational traffic estimates considered within the 'Transport' chapter of this volume. The radiological impact of the transport of LLW waste is covered by the 'Radiological' chapter.	**Chapter 10;** **Chapter 25** of this volume.

Activity	Description	Chapter
Decommissioning of LLW management facilities.	Decommissioning of the LLW management facilities have been reviewed within the 'Description of Decommissioning' chapter of this volume.	**Chapter 5** of this volume.

b) Intermediate level waste management activities

7.8.2 The likely effects associated with the ILW management activities proposed at Sizewell C have been considered as part of the Sizewell C construction and operational assessments within specific chapters of this volume. **Table 7.10** identifies the chapters where the construction, operation and decommissioning of ILW management facilities are addressed in greater detail.

Table 7.10: Location of further information on ILW management activities.

Activity	Description	Chapter
Processing of ILW for off-site transfer.	The processing of ILW in preparation for interim storage and eventual disposal to the Geological Disposal Facility would take place within purpose-built facilities. These processes would result in very small discharges of radioactivity. The impact of Sizewell C radiological discharges is considered within the 'Radiological' chapter of this volume.	**Chapter 25** of this volume.
Interim storage of ILW.	The interim storage of ILW prior to transfer and disposal at the Geological Disposal Facility would take place within the purpose built ILW Interim Storage Facility. The store would be required to be compliant with the Nuclear Site Licences, and Radioactive Substances Regulations permit with regard to radiological safety and discharges and as such the impacts would be carefully controlled and minimised through ALARP and BAT. The implications of direct dose and discharges from the ILW Interim Storage Facility are considered in the 'Radiological' chapter of this volume.	**Chapter 25** of this volume.
Construction of ILW management facilities.	The construction of the ILW processing and ILW Interim Storage Facility would be part of the main development site construction activities, which are detailed within the 'Description of Construction' chapter of this volume.	**Chapter 3** of this volume.
Decommissioning of ILW management facilities.	The decommissioning of the ILW Interim Storage Facility would only take place when all operational ILW has been transferred from Sizewell C. Decommissioning of the ILW management facilities are considered in the 'Description of Decommissioning' chapter of this volume.	**Chapter 5** of this volume.

c) Spent fuel management activities

7.8.3 The likely effects associated with spent fuel management activities proposed at Sizewell C have been considered as part of the Sizewell C construction and operational assessments within the specific chapters of this volume. **Table 7.11** identifies where the construction, operation and decommissioning of the spent fuel management facilities are covered in greater detail.

Table 7.11: Location of further information on spent fuel management activities.

Activity	Impact	Chapter
Interim storage of spent fuel.	The interim storage of spent fuel prior to transfer and disposal at the Geological Disposal Facility would take place within the purpose-built spent fuel Interim Storage Facility. The store would be required to be compliant with the Nuclear Site Licences and Radioactive Substances Regulations permit with regard to radiological safety and discharges, and as such the impacts would be carefully controlled and minimised through ALARP and BAT. The implications of direct dose and discharges from Sizewell C are considered in the 'Radiological' **chapter** of this volume.	**Chapter 25** of this volume.
Construction of spent fuel management facilities.	Construction of facilities associated with spent fuel management would be part of the main development site construction activities, which are detailed within the 'Description of Construction' **chapter** of this volume.	**Chapter 3** of this volume.
Decommissioning of spent fuel management facilities.	The decommissioning of the spent fuel Interim Storage Facility would only take place when all operational spent fuel has been transferred from Sizewell C to Geological Disposal Facility. Decommissioning of the spent fuel management facilities are considered in the 'Description of Decommissioning' **chapter** of this volume.	**Chapter 5** of this volume.

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