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Holtec Britain Ltd	HI-2240355
Sponsoring Company	**Document Reference**
0	30 September 2024
Revision No.	**Issue Date**
Report	Non-proprietary
Record Type	**Proprietary Classification**
ISO 9001	No
Quality Class	**Export Control Applicability**

Record Title:

PSR Part B Chapter 26 Decommissioning Approach

Proprietary Classification

This record does not contain commercial or business sensitive information.

Export Control Status

Export Control restrictions do not apply to this record.

Revision Log

Revision	Description of Changes
0	First Issue to Regulators

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26.1 INTRODUCTION

The Fundamental Purpose of the Generic Design Assessment (GDA) Safety, Security and Environment Case (SSEC) is to demonstrate that the Generic Small Modular Reactor (SMR)-300 can be constructed, operated, and decommissioned on a generic site in the UK to fulfil the future licensee's legal duties to be safe, secure and protect people and the environment as defined in Holtec SMR GDA Preliminary Safety Report (PSR) Part A Chapter 1 'Introduction' [1].

The Fundamental Purpose is achieved through the Fundamental Objective of the PSR, which is to summarise the safety standards and criteria, safety management and organisation, claims, arguments and intended evidence to demonstrate that the Generic SMR-300 design risks to people are likely to be tolerable and As Low as Reasonably Practicable (ALARP).

Holtec SMR GDA PSR Part B Chapter 26 of the PSR presents the Claims, Arguments and Evidence (CAE) for the design and strategy for the decommissioning of the Generic SMR-300.

26.1.1 Purpose and Scope

The Overarching SSEC Claims are presented in PSR Part A Chapter 3 'Claims, Arguments & Evidence' [2].

This chapter (Part B Chapter 26) links to the overarching claim through Claim 2.3:

Claim 2.3: The design and safety assessment of the Generic Holtec SMR-300 considers the entire reactor lifecycle.

As set out in Chapter A3 [2], Claim 2.3 is further decomposed across several topics which are responsible for the development of the design of relevant Structures, Systems and Components (SSCs) and management strategies. This chapter presents the decommissioning approach for the Generic SMR-300 and therefore directly supports a claim focused on the safe decommissioning of the reactor, Claim 2.3.2:

Claim 2.3.2: The Generic Holtec SMR-300 can be safely decommissioned.

Discussion on how this is broken down into four further sub-claims which are to be addressed by this chapter, together demonstrating Claim 2.3.2 has been met, is provided in Subchapter 26.2.

This chapter provides an initial overview aimed at providing confidence that:

- The design of the generic SMR-300 will facilitate future decommissioning and that the radiation exposure to the operational staff and public are minimised to ALARP.
- The generation of wastes will be minimised in accordance with the principles of Best Available Technique (BAT) (quantities and activities).
- The impacts on the environment are minimised during all phases of the life of the SMR-300.
- Cost is minimised to the extent practicable by simplifying the decommissioning process.

- An initial decommissioning strategy of the generic SMR-300 will be prepared and maintained for the chosen site and will be completely integrated with all other relevant chapters.

This chapter covers the codes and standards associated with the decommissioning approach (subchapter 26.3), the decommissioning strategy (subchapter 26.426.3.2), design for decommissioning (subchapter 26.5), disposal routes and storage (subchapter 26.6), and faults and hazards relating to decommissioning (subchapter 26.7).

The design of the generic SMR-300 is an evolution of the design of the SMR-160. The design transition to the generic SMR-300 is a developing process; however, the design philosophy, strategy, and overall safety system architecture, including the applicable codes and standards, remain unchanged from the mature design of the SMR-160. Therefore, it is appropriate to use SMR-160 documents for the SMR-300 design. For further details of the design evolution, refer to the SMR-300 Generic Design Assessment (GDA) Scope [3].

For clarity, information related to the design within this chapter is taken from documentation developed during the design of the SMR-160. The information should be seen as indicative only. As the documentation provided relating to decommissioning is relevant to the SMR-160, this is subject to change due to design evolution associated with the development of the generic SMR-300 design.

There are currently no exclusions identified from the decommissioning scope.

A master list of definitions and abbreviations relevant to all PSR Chapters can be found in Holtec SMR GDA PSR Part A Chapter 2 General Design Aspects and Site Characteristics [4].

26.1.2 Assumptions

No assumptions are identified in this revision.

26.1.3 Interfaces with other SSEC Chapters

As with all safety case topic areas, decommissioning both influences and is influenced by other topic areas. Decommissioning is fundamental to the design and therefore interfaces with every topic which comprises the PSR. However, key interfaces are described below.

Holtec SMR GDA PSR Part B Chapter 13 Radioactive Waste Management [5] concerns management of radioactive waste arising from the reactor. This is a co-topic with decommissioning under Nuclear Liabilities Regulations (NLR) in terms of radioactive wastes arising from the decommissioning of the SMR-300.

The strategy identified for storage and management of spent fuel in Holtec SMR GDA PSR Part B Chapter 24 Fuel Transport and Storage [6] will impact the decommissioning strategy and influence the phased approach to decommissioning.

Holtec SMR GDA PSR Part B Chapter 10 Radiological Protection [7] concerns the radiation protection of workers and operators of the plant. During the design phase, design for decommissioning should be considered to reduce the dose to operators during the decommissioning phase of the project. Similarly, Holtec SMR GDA PSR Part B Chapter 23 Reactor Chemistry [8] considers minimisation of source term and spread of contamination with respect to design for decommissioning.

Holtec SMR GDA Part B Chapter 19 Mechanical Engineering [9] covers Mechanical Engineering. The mechanical design of the SSCs will have influence on the claims placed on the decommissioning approach.

Holtec SMR GDA Part B Chapter 20 Civil Engineering [10] covers Civil Engineering. The construction of the SMR-300 from a Civil Engineering perspective will influence the strategy selected for the decommissioning of the SMR-300.

Holtec SMR GDA PSR Part B Chapter 25 Construction and Commissioning Approach [11] discusses Construction and Commissioning. The method employed for construction and commissioning of the plant will influence the strategy employed for the decommissioning of the plant. The construction strategy may introduce laydown areas for construction equipment which may be applicable to decommissioning and will influence the phases of the decommissioning strategy.

There is also a crossover between this topic and the Preliminary Environmental Report (PER). Holtec SMR GDA PER Chapter 1 Radioactive Waste Management Arrangements [12] is applicable as this discusses the potential management of radioactive waste arising during the decommissioning stage and decommissioning waste strategy. Additionally, the use of BAT when planning for decommissioning must be demonstrated.

26.2 DECOMMISSIONING APPROACH CLAIMS, ARGUMENTS, EVIDENCE

The primary purpose of a CAE approach is to capture the golden thread of a safety case narrative to demonstrate how plant and operational evidence is brought together and to justify that a high-level or fundamental claim is true. In the context of the GDA of the generic SMR-300, that is how the Fundamental Purpose of the overarching SSEC (presented in Part A Chapter 1 [1]) is achieved.

The Fundamental Purpose follows a golden thread throughout the SSEC to CAE via the objectives of the PSR, the Preliminary Environmental Report (PER) and the Generic Security Report (GSR). The overarching SSEC claims and the philosophy for their architecture is presented in Part A Chapter 3.

This chapter contributes directly to Claim 2.3, which is focused on the demonstration that the whole reactor lifecycle has been considered in the design and safety assessment.

Claim 2.3: The design and safety assessment of the Generic Holtec SMR-300 considers the entire reactor lifecycle.

As set out in Part A Chapter 3 [2], Claim 2.3 is further decomposed across several engineering disciplines which are responsible for the development of the design of relevant Structures, Systems and Components (SSCs) and management strategies. This chapter presents the decommissioning approach for the Generic SMR-300 and therefore directly supports a claim focused on the safe decommissioning of the reactor, Claim 2.3.2:

Claim 2.3.2: The Generic Holtec SMR-300 can be safely decommissioned.

Claim 2.3.2 is further decomposed within this chapter, to provide confidence that the relevant requirements for decommissioning will be met. This has been done by breaking down Claim 2.3.2 into four further sub-claims which are to be addressed by this chapter.

Claim 2.3.2.1 ensures that the Generic SMR-300 shall have a thorough and sufficient decommissioning strategy which enables safe and prompt decommissioning when this is desired to take place.

Claim 2.3.2.2 contributes to the design phase of the reactor by ensuring that features are incorporated which facilitate decommissioning using proven current technology, thereby reducing the risks during decommissioning.

Claim 2.3.2.3 ensures that there are disposal routes and storage facilities available to accommodate the waste generated through decommissioning.

Claim 2.3.2.4 ensures that all faults and hazards relating to decommissioning are identified and assessed, and risks shown to be capable of being ALARP.

Table 1 shows in which subchapter of this PSR each of these claims are demonstrated to be met.

Table 1: Claim Subchapters

Claim No	Claim	Chapter Section
2.3.2.1	The decommissioning strategy for the Generic Holtec SMR-300 shall enable decommissioning to be safely undertaken as soon as is reasonably practicable.	26.4 DECOMMISSIONING STRATEGY
2.3.2.2	The Generic Holtec SMR-300 incorporates features that facilitate decommissioning and can be decommissioned using current, proven technology.	26.5 DESIGN FOR DECOMMISSIONING
2.3.2.3	Credible disposal routes and storage facilities are (or will be available) prior to disposal for all decommissioning wastes.	26.6 DISPOSAL ROUTES AND STORAGE
2.3.2.4	Faults and hazards of Generic SMR-300 decommissioning are identified and assessed, and risks are shown to be capable of being ALARP.	26.7 DECOMMISSIONING FAULTS AND HAZARDS

A summary of the current CAE route map for Part B Chapter 26 is provided in Appendix A and a further update on claim decomposition, argument development and evidence maturity will be provided in the subsequent update of this Chapter.

26.3 CODES, STANDARDS AND METHODOLOGIES

This subchapter outlines the codes and standards used in the decommissioning approach. The Requesting Party (RP) recognises that UK nuclear safety regulations are based on a non-prescriptive regime and consequently the technical codes and standards that must be used for nuclear power plant are not prescribed. However, the codes and standards must represent RGP. New codes and standards can be introduced where needed by say, novel design features. Use of such codes will be justified in each case.

26.3.1 US Codes, Standards and Methodologies used for the Decommissioning Approach of the SMR-300

The US Nuclear Regulatory Commission (NRC) requires licensees to ensure that design and procedures for operation of new facilities would minimise contamination and facilitate decommissioning as per 10 CFR 20.1406 [13].

The information presented within this chapter is largely based on the Design Standard for Decommissioning [14] which incorporates guidance on the decommissioning of Nuclear Power Plants (NPP) from Regulatory Guide G-219 [15] and Nuclear Regulatory Commission Technical Report Designation (NUREG) NUREG-1575 [16].

26.3.2 UK Regulations, Policy and Strategy

UK legislation, policy and strategy relevant to Decommissioning can be found in Table 2 (Regulations) and Table 3 (Policies).

Table 2: UK regulations relevant to decommissioning

Title	Date
The Nuclear Installations Act [17]	**1965**
Ionising Radiations Regulations [18]	**2017**
Environment Act [19]	**2021**
Radioactive Substances Regulation	**2010**
The Construction (Design and Management) Regulations [20]	**2015**
The Environmental Permitting (England and Wales) Regulations [21]	**2016**
The Environmental Permitting (England and Wales) (Amendment) Regulations [22]	**2018**
The Environmental Permitting (England and Wales) (Amendment) (No. 2) Regulations [23]	**2018**

Table 3: UK policies relevant to decommissioning

Title	Region
Policy for the Long-Term Management of Solid Low Level Radioactive Waste in the United Kingdom [24]	**UK**
The Management of Higher Activity Radioactive Waste on Nuclear Licensed Sites [25]	**UK**
UK Strategy for the Management of Solid Low-Level Waste from the Nuclear Industry [26]	**UK**

As part of the site-specific licensing process, the prospective licensee must comply with all the nuclear site licence conditions (LC). LC 35 [27] relates specifically to decommissioning and all licensees are required to make and implement adequate arrangements for the decommissioning of any plant or process which may affect safety.

Furthermore, LC 35 requires the licensee to divide the decommissioning into stages, where appropriate; moving from one stage to the next is permissioned by Office for Nuclear Regulation (ONR) under LC 35(5). These stages are typically divided as follows, Determining the timing and pace of decommissioning - code of practice [28] and License condition Handbook [27]:

- **Post-operational clean out:** where the bulk of the radioactive material, such as spent fuel, operational radioactive waste and waste arising from system draining and decontamination activities are removed from the facility.
- **Dismantling:**
    - **Deferred dismantling:** making preparations through removal of residual radioactive waste and other plant items prior to putting the facility into a defined period of care and maintenance to accrue the benefits of radioactive decay prior to final dismantling;
    OR
    - **Immediate (prompt) dismantling:** initial work is to remove residual radioactive material and waste prior to the demolition of structures; and remediation of land to meet an agreed end-state; and
- **Final site clean-up:** to a point where the site may have its nuclear site license revoked by the ONR.

Typically, the ONR will agree a set of key decommissioning milestones with the licensee, and these are included in its programme and progress with decommissioning is permissioned and monitored through meeting of these milestones.

Prior to commencing the decommissioning of shutdown nuclear reactors, there is a requirement to assess the potential environmental impact of decommissioning these facilities. Work cannot start until ONR issues its Consent under The Nuclear Reactors (Environmental Impact Assessment of Decommissioning) Regulations (EIADR) [29].

In addition to LC35, the following LCs are identified as being relevant to decommissioning [27]:

- LC 4 – Restrictions on nuclear matter on the site
- LC 6 – Documents, records, authorities and certificates
- LC18 – Radiological protection
- LC 25 – Operational Records
- LC 28 – Examination, inspection, maintenance and testing
- LC 32 – Accumulation of radioactive waste
- LC 33 – Disposal of radioactive waste
- LC 34 – Leakage and escape of radioactive waste

Furthermore, the ONR has developed a list of Safety Assessment Principles (SAP) [30] and corresponding Technical Assessment Guides (TAG) relevant to decommissioning in the UK. The

SAPs relevant specifically to decommissioning can be found within Table 5. The TAG relevant directly to decommissioning is NS-TAST-GD-026 [31]; however, NS-TAST-GD-017 [32] is also relevant.

The Environment Agency (EA) has developed the Radioactive Substances Management Developed Principles (RSMDPs) [33] which are the equivalent to the ONRs SAPs:

- RSMDP3 – Use of BAT to Minimise Waste.
- RSMDP9 – Characterisation.
- RSMDP12 – Limits and Levels on Discharge.
- RSMDP14 – Record Keeping.

26.3.3 International Guidance

Table 4 presents international guidance relevant to the decommissioning of nuclear power plants and has been included as examples of good practice. This list is non-exhaustive.

Table 4: International guidance relevant to decommissioning

Body	Title	Reference
International Atomic Energy Agency (IAEA)	Decommissioning of Facilities, Generic Security Report (GSR) Part 6	[34]
IAEA	Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities Safety Guide, SSG-47	[35]
IAEA	Design and Construction of Nuclear Power Plants to Facilitate Decommissioning, Technical Report Series No382	[36]
IAEA	Release of Sites from Regulatory Control on Termination of Practices, Safety Guide WS-G-5.1	[37]
Western European Nuclear Regulators' Association (WENRA)	Decommissioning Safety Reference Levels Report	[38]

Lessons learned are also available from the US NRC, Nuclear Energy Agency (NEA), IAEA and WENRA [39]. Some examples are the Decommissioning Lessons Learned database on the NRC website [40], and NEA No. 6924 [41].

26.3.4 US vs UK Regulatory Gap Analysis

A summary of how the SAPs relevant to decommissioning align to the US NRC regulations can be found in Table 5 below.

Table 5: US vs UK Regulatory Gap Analysis

Decommissioning SAPs (ONR)			Potential Gap with US NRC Regulations
DC.1	Design and operation	This principle relates to consideration of decommissioning during the planning, design construction and operation of a new facility, or modification to an existing facility to facilitate safe decommissioning.	It is a regulatory requirement within the US per 10 Code of Federal Regulations (CFR) 20.146 [13] that the facility design will facilitate eventual decommissioning. Guidance [39] and lessons learned [42] on incorporating decommissioning within the design of nuclear power plants in the US is taken from the US NRC and international bodies such as the IAEA and the Nuclear Energy Agency.
DC.2	Decommissioning strategies	This principle relates to preparation and maintenance of a decommissioning strategy that is appropriately integrated with other relevant strategies.	Guidance on development of a decommissioning strategy within the US is provided within NUREG-1757 [43]. A preliminary decommissioning strategy relevant to UK context shall be developed within Step 2.
DC.3	Timing of decommissioning	This principle relates to timing of decommissioning and justification of the continuing safety of the facility for the period prior to its decommissioning, with identification of any necessary remedial and operational measures to reduce the risk where this cannot be underpinned.	Guidance on timing of decommissioning within the US is provided within NUREG-1757 [43]. A preliminary decommissioning strategy relevant to UK context relevant to UK context shall be developed within Step 2.
DC.4	Planning for decommissioning	This principle relates to preparation of a decommissioning plan that sets out how the facility will be safely decommissioned.	Decommissioning plans are a requirement for certain nuclear sites within the US. A decommissioning plan will be developed within the site-specific licensing stage.
DC.5	Passive safety	This principle relates to facilities being passively safe before entering a care and maintenance phase.	This is a current gap between the US and UK regulations in that there is no requirement for passive safety in the US. This will be addressed within the Preliminary Decommissioning Strategy being developed during Step 2

Decommissioning SAPs (ONR)			Potential Gap with US NRC Regulations
DC.6	Records for decommissioning	This principle relates to identification, preparation, update, retention and ownership of documents and records required for decommissioning purposes.	The US NRC prescribes the recordkeeping responsibilities for decommissioning within 10 CFR 20 [13], 30 [44], 40 [45], 70 [46] and 72 [47]. Record keeping shall be included within the preliminary decommissioning strategy developed in Step 2.
DC.7	Decommissioning organisation	This principle relates to arrangements for establishing and maintaining the decommissioning organisation to ensure safe and effective decommissioning.	Organisation of decommissioning is covered within 10 CFR 30 [44], 40 [45], 70 [46] and 72 [47]. Organisation of the decommissioning shall be included within the preliminary decommissioning strategy developed during Step 2.
DC.8	Management system	This principle relates to periodic review and modification to the management system prior to and during decommissioning.	Management of decommissioning is covered within 10 CFR 30 [44], 40 [45], 70 [46] and 72 [47]. Organisation of the decommissioning shall be included within the preliminary decommissioning strategy developed within step 2.
DC.9	Decommissioning safety case	This principle relates to preparation of the decommissioning safety case to demonstrate the safety of the decommissioning plan and its associated decommissioning activities, which is to be kept up to date as the work progresses.	Within 10 CFR 20.1403 [13] it is required that as part of the site license termination there is sufficient analysis on the remaining risks of the site. Within 10 CFR 30.36 [44] it prescribes the activities required for the decommissioning plan as well as justification that the site is safe for license termination. This will be covered as the decommissioning plan is developed during the site-specific phase.
ECE.26	Civil Engineering: Design – Provision for decommissioning:	Special consideration should be given at the design stage to the incorporation of features to facilitate radioactive waste management and the future decommissioning and dismantling of the facility.	See DC.1.

26.4 DECOMMISSIONING STRATEGY

Claim 2.3.2.1: The decommissioning strategy for the Generic Holtec SMR-300 shall enable decommissioning to be safely undertaken as soon as is reasonably practicable.

26.4.1 Decommissioning Activities

The preliminary decommissioning strategy for the generic SMR-300 is still being developed; however, the general approach being targeted is a combination of prompt decommissioning and storage with surveillance decommissioning. Presently, there is foreseen to be two phases to the decommissioning activities for the generic SMR-300. These are outlined below.

Notwithstanding, an exercise will be conducted to assess how the proposed decommissioning strategy aligns with the UKs decommissioning policy as and when the strategy is developed further during the design of the SMR-300. The SMR-300 decommissioning approach should be guided by a historical site assessment, a comprehensive document prepared that examines the locations for contamination to be remediated and monitored.

26.4.1.1 Phase 1 Activities

It should be noted that prior to the commencement of Phase 1 it would be anticipated that there would be a period of Post Operational Cleanout (POCO) whereby operational material and wastes shall be stored in a passively safe manner or removed from the facility where appropriate. These activities would include, but are not limited to:

- Evaluating support systems outlined in Section 26.5 for their required support during decommissioning activities.
- Constructing a crane outside the Containment Enclosure Structure (CES) for the removal of large components through the Containment Structure (CS) top hatch.
- Conducting characterisation to assess anticipated dose (both radiological and dose due to hazardous substances, e.g., toxicity) to occupational workers and determining contamination levels in equipment to estimate the radiological waste inventory.

26.4.1.2 Phase 2 Activities

Decommissioning operations will include the dismantling and removal of all systems structures and components within the CES, Reactor Auxiliary Building (RAB) and Turbine Building (TB) as well as the dismantling of all other structures. These activities would include, but are not limited to:

- Remove spent nuclear fuel to dry storage and thus allow inactivation of the spent fuel pool and associated support systems and structures. Then dismantle the spent fuel pool.
- Create openings as needed into the CES for removal of equipment and waste packages.
- Segment the reactor into sections that can be packaged for removal via the top hatch.
- Remove, package, and dispose of all piping and components no longer needed for decommissioning. Also decontaminate or remove all components and piping systems that will minimise worker exposure in the following steps.

- Remove the steam generator and pressuriser through the CS top hatch. Steam generator volume reduction may be attempted after the steam generators are removed.
- Remove the flange from the reactor vessel.
- Remove the reactor vessel through the CS top hatch.
- Sever remaining large bore and small bore piping to allow components and piping segments to be lifted out. Remove other large components through the CS top hatch, where applicable.
- Remove reactor coolant system piping and start up pumps.
- Remove all activated concrete used for biological shielding and all accessible contaminated concrete.
- Remove all fuel racks and any debris from the spent fuel pools.
- Remove all remaining contaminated equipment and decontaminate the buildings.
- Remove all remaining components and equipment used to support decommissioning.

26.4.2 CAE Summary

The Preliminary Decommissioning Strategy is being developed to allow for demonstration of Claim 2.3.2.1 within Revision 1 of this PSR Chapter. To ensure the safe decommissioning of the Generic SMR-300 within the UK, the Preliminary Decommissioning Strategy is being developed in accordance with the UK's decommissioning policy [48].

26.5 DESIGN FOR DECOMMISSIONING

Claim 2.3.2.2: The Generic Holtec SMR-300 incorporates features that facilitate decommissioning and can be decommissioned using current, proven technology.

The ONR SAP DC.1 states that "Facilities should be designed and operated so that they can be safely decommissioned". Therefore, the design of the generic SMR-300 shall consider decommissioning at all stages of the design process.

The following requirements that should be considered during the design phase to facilitate decommissioning are stated in Design Standard for Decommissioning [14] which incorporates guidance of CNSC Regulatory Guide G-219 [15]:

- Minimise the generation and spread of radioactive material during normal operation and decommissioning.
- Confine radioactive material during normal operation including leaks and faults.
- Enhance access to contaminated material or equipment to facilitate its removal.
- Enhance structural decontamination through surface preparation.
- Minimise the quantity of non-radioactive hazardous wastes generated through decommissioning activities.
- Minimise the quantity of radioactive wastes generated through decommissioning activities.
- Ensure that the risk of radiation exposure to both decommissioning personnel and the general public is ALARP.
- Provide protection of the health and safety of the public, and the environment.
- Provide a suitable Intermediate Storage Facility (ISF) for both waste and spent fuel.

The requirements listed above broadly align with the RSMDPs [33] and WENRA [38] and are to be accomplished by integration of good practice into the design of the generic SMR-300.

To achieve this, the following design features shall be considered:

- Reduction of the radiation source.
- Plant layouts that limit the spread of contamination.
- Facilitation of dismantling and decontamination of radioactive equipment.
- Simplification of Waste Management.
- Information management to facilitate decommissioning.

These are summarised in the following subchapters.

26.5.1 Design Features

26.5.1.1 Reduction of Radiation Source Term to Minimise Decommissioning Radioactive Waste

26.5.1.1.1 Fuel Design

The main contamination barrier is the integrity of the nuclear fuel. This is maintained through rigorous management of primary system chemistry and the maintenance of steam generator tube integrity.

In particular, rigorous controls on foreign material exclusion for primary systems and when the reactor head is open is a key means of avoiding fuel fretting and subsequent fuel damage. Plant drain systems for reprocessing of wastewater must be managed to avoid organic contaminants being passed through filter systems and eventually into the reactor through make up water systems. Thus, chemistry control for operating plants on top of a well-informed design and selection of materials is essential to minimise eventual decontamination and disposal costs.

Management of the primary system chemistry is discussed in PSR Part B Chapter 23 Reactor Chemistry [8]. The design and integrity of the reactor and its primary systems is described in PSR Part B Chapter 1 Description of the Reactor Coolant System and Engineered Safety Features [49], PSR Part B Chapter 2 Reactor Fuel and Core [50] and PSR Part B Chapter 5 Description of the Reactor Supporting Facilities [51].

26.5.1.1.2 Material Selection

Appropriate selection of the materials exposed to high neutron flux will minimise the radionuclide inventory at the end of the reactor's operational life. The presence of a heavy reflector will further minimise the radionuclide inventory by reducing the neutron flux that reaches these selected materials.

Selection of materials influences activation behaviours. By minimising certain elements within the materials, such as cobalt within stainless steel, it minimises the overall inventory of activated corrosion products (^{58}Co and ^{60}Co) resulting from those elements. Minimisation of readily activated impurities within steel and concrete can be minimised by ensuring strict quality assurance during the specification process.

Material selection is discussed further in PSR Part B Chapter 10 [7] and PSR Part B Chapter 23 [8].

26.5.1.1.3 Reduction of Surface Contamination

The following non-exhaustive list of considerations will be implemented to reduce surface contamination, aiding in the reduction of the overall radiation source:

- Surfaces likely to be contaminated should be designed to be easily decontaminated.
- Surfaces should be assured to be smooth to minimise potential deposition and hold-up.
- Surfaces should be pre-treated to reduce contamination.

- Provisions should be made for containment of liquid spills to reduce spread of contamination.
- Steel liners should be used in all areas where concrete may be exposed to spills to minimise the amount of activated / contaminated concrete required to be disposed of as waste.
- Ceilings, floors, and walls should be sealed to prevent the intrusion of radioactive materials.
- Reactor coolant chemistry should reduce the transportation and depositing of activated corrosion products (see PSR Part B Chapter 23 [8]).

26.5.1.2 Plant Layout to Minimise Contamination

The following considerations should be given to the layout of the plant:

- Equipment should be grouped based on activity inventories and process streams so that higher radiation areas may be segregated from non- or lesser-radiation areas.
- Airflow must always be from areas of lower potential airborne contamination to areas of higher potential airborne contamination.
- Planned removal pathways for tanks and vessels, including laydown areas.
- Isolation of radioactive waste systems (see PSR Part B Chapter 13 [5] for more detail) for more detail.
- Location of floor drain collection, to prevent stagnation or spillage of radioactive water.
- Drains that have the possibility of entraining oil or hydraulic fluids should be segregated from reactor water or secondary side water reprocessing.

The IAEA Manual on Decontamination methodologies and approaches [52] and IAEA TECDOC on lessons learnt [53] can be used as a guide. Plant Layout with respect to minimization of contamination is discussed in detail in PSR Part B Chapter 10 [7].

26.5.1.3 Facilitation of Dismantling and Decontamination of Radioactive Equipment

The US Army produced general design criteria to facilitate the decommissioning of nuclear facilities [54]. The following considerations are taken from this guidance and are deemed to be RGP for design for decommissioning, noting that they are in line with design considerations listed in the ONR TAG for Decommissioning (NS-TAST-GD-026) [31].

Overall system and equipment design with respect to radiological protection and design for decontamination is discussed in detail in PSR Part B Chapter 10 [7].

26.5.1.3.1 Pipes and Ducts

The following considerations should be given to pipes and ducts:

- Pipes, sumps, and drains containing radioactive material shall be easily accessible.

- Pipes, ducts, and equipment which potentially could be contaminated should not be embedded in walls, floors, or ceilings, or buried underground however, consideration may also need to be given to the shielding requirements for dose reduction.

26.5.1.3.2 Sumps and Drains

The following considerations should be given to sumps and drains:

- For sumps, which may become contaminated, a doubled walled design is preferred, to provide an additional level of containment.
- Pumps should be equipped with collection pans for leakage collection.
- Drains should be routed to appropriate sumps. This routing should consider the fluid quality (including high or low activity).
- Floor drains should be prominently marked to guard against unintended chemical disposal pathways.
- Drains shall be equipped with quick disconnects to connect hoses directly to a contaminated sump to keep radioactive waste from running across the floor to a drain.

The Radioactive Drain System (RDS) collects any potential liquid waste generated or leaked via floor drains and discharges to the appropriate Liquid Radwaste subsystem for processing. The RDS is described in detail in PSR Part B Chapter 13 [5].

26.5.1.3.3 Tanks

The following considerations should be given to tanks:

- Tanks containing contaminated fluids should not be buried but placed in above ground rooms, where practical.
- Overflow lines from tanks containing radioactive liquids should be routed to a contaminated sump or another collection tank.
- Vent lines from tanks containing radioactive liquids should be connected to an active ventilation system upstream of the filtration systems to minimize both in-plant airborne activity and plant releases.

26.5.1.3.4 Integration of Radioactive and Clean Facilities

The following considerations should be given to the integration of radioactive and clean facilities:

- Uncontaminated systems should not receive effluents from contaminated areas.
- Equipment should be grouped based on activity inventories and process stream so that higher radiation areas may be segregated from non- or lesser-radiation areas and to minimise runs of interconnecting radioactive piping.
- Consideration should be given to providing separate ventilation systems for contaminated and clean portions of a facility.

Zoning of plant with respect to minimising spread of contamination are detailed further in PSR Part B Chapter 10 [7].

26.5.1.3.5 Consideration of Crud Traps

The following considerations should be given to crud traps:

- Instrument taps should not come off the bottom of piping.
- Drain connections designed to minimise crud collection or the ability to flush the line.
- Sloped lines to drain points.
- Avoid tight bends in piping.
- Tanks with sloped bottoms leading to a drain.
- Sloping pipe in the direction of flow.
- Welding and valve selection that avoids internal dead spots for flow.

26.5.1.3.6 Ventilation Systems

The following considerations should be given to the ventilation systems:

- Proper design of the ventilation system is critical in that it must ensure that clean areas do not receive contaminated air flows.
- Filters should be located as near to the ventilated area as possible to minimise contamination to the duct work.
- Consideration shall be given to frequent air changes and filtration in areas where radioactive gases are expected.
- Seams and joints in fume hoods and ventilation ductwork should be kept to a minimum.

The design of the ventilation system is detailed in PSR Part B Chapter 5 [51] with radiological protection features relevant to decommissioning discussed in PSR Part B Chapter 10 [7].

26.5.1.3.7 Electrical Systems and Equipment

Design and placement of electrical systems should allow isolation from contaminants where possible and facilitate removal and cleaning during decommissioning. As structures are to be dismantled, consider that fire detection and life safety systems may need to remain operational until just before taking the structure to cold and dark. Thus, segregation of these power supplies from the structure main feeds is encouraged.

As systems and electrical distribution may be modified from initial construction through the end of life, care must be taken to accurately record new buried piping and electrical conduit locations. As the plant ages, abandoned systems and circuits should be well identified to facilitate future dismantlement and to support assurance that zero energy remains and all fluid contents have been drained.

26.5.1.3.8 Personnel and Equipment Access

The design should ensure there is simple access to components to facilitate quick and easy dismantling which will minimise dose to workers. Suitable access to the ISF should be provided in the design as required.

26.5.1.3.9 Intact Removal of Large Components

Dismantling of large components does not have to rely upon the route used the place the component during initial construction. However, it is appropriate to consider how the component might be segmented in place or otherwise freed from its foundation especially where shutdown radiation levels may limit worker occupancy times.

26.5.1.3.10 Dismantling Aids

For equipment which cannot be removed intact, pre-placement of dismantling aids should be considered to facilitate dismantling and segmentation of components and reduce occupational exposure.

26.5.1.3.11 Shielding

Shielding and dividing walls not performing safety functions should be designed for simple demolition.

26.5.1.3.12 Overhead Cranes and Installed Lifting Equipment

The overhead cranes installed for plant maintenance and refueling will continue to have roles in the decommissioning process. These components should be included in equipment management programs that will assure their usefulness in the period of decommissioning.

26.5.1.3.13 System Operations

Considerations shall be made for the following systems which may be required during different stages of decommissioning:

- Fire Protection System.
- Radiological and Environmental Monitoring System.
- Equipment and Floor Drainage System.
- Liquid Radwaste System.
- Solid Radwaste System.
- Gaseous Radwaste System.
- Emergency Lighting System.
- Plant Lighting System.
- Radiologically Controlled Area Heating, Ventilation and Air Conditioning (HVAC).
- Containment Ventilation System.
- Service Water System.
- Overhead Heavy Load Handling System.
- Light Load Handling System.

After the operational phase of the power plant has ended, there shall be provisions for the fuel handling area in the containment and for the RAB to be operational for an additional 6 to 7 years, or until the spent fuel is sufficiently cooled to be moved to the Interim Spent Fuel Storage Installation (ISFSI).

Considerations should be given to the design of the building structures as they may potentially have longer term integrity requirements due to the need for availability during decommissioning.

Fire protection should additionally be available within areas where waste is being stored until the building has been totally decommissioned.

26.5.1.4 Simplification of Waste Management

Radioactive Waste Management SSCs and Radioactive Waste Management Arrangements are discussed in PSR Part B Chapter 13 [5] and PER Chapter 1 [12], respectively, with key aspects relating to Decommissioning summarised below. Through simplification of the waste management systems, the volume of material requiring disposal can be minimised.

26.5.1.4.1 Waste Process Design Features

The radioactive waste management arrangements minimise the volume of secondary wastes arising from the reactor, further information on the SSCs providing radioactive waste management functions can be found in PSR Part B Chapter 13 [5]. This in turn reduces the overall volume of radioactive waste to be disposed of during the decommissioning phase in accordance with the ONR SAPs. Furthermore, through development of the Integrated Waste Strategy (IWS) and engaging with Nuclear Waste Services (NWS) on the disposability assessment (discussed further within Subchapters 26.6.1.3 and 26.6.1.4, respectively), the waste management process has been streamlined and simplified, reducing the volume of decommissioning waste requiring disposal.

26.5.1.4.2 Avoiding Mixed Waste Creation

Mixed wastes such as lubricating oils contaminated with radioactive materials are very problematic for disposal. Many disposal sites are not equipped to handle mixed waste nor licensed for their disposal. Substantial costs are generally incurred with handling and disposal of mixed waste, thus avoiding their creation is a very useful cost control.

26.5.1.5 Information Management to Facilitate Decommissioning

A documentation program should be established during the design phase to collect and update information related to the plant design and its operation. This should include drawings and design specifications and any updates to those. Additionally, photographs of significant plant structures and foundations have proven invaluable in planning for eventual dismantlement. Given future technology changes, hard copy full page sized photographs are recommended for retention. This program will allow for adequate planning for the decommissioning period.

In addition to information management, a suitable knowledge management system will need to be developed and implemented. This will involve establishing a knowledge acquisition/recording process for learning from experience in worldwide decommissioning projects, and a means of extracting and retaining knowledge and expertise from experienced engineers.

26.5.2 Decontamination Regime

As described above, design features shall be integrated to allow for ease of decontamination. The goal of decontamination is to remove entirely or reduce to the maximum extent practicable, the radioactive contamination within or on the surface of materials and SSCs. By minimising the radioactive contamination this shall, in turn, reduce radiation exposures during decommissioning activities as well as reducing the overall volume of material classified as radioactive waste requiring disposal.

There is considerable world-wide experience in the use of decontamination methods and regimes in nuclear power plants and this experience will be considered in developing the strategy and approach to decontamination. In addition, several decontamination methods and regimes will be evaluated such as a through-life decontamination regime to minimise the radioactive decontamination periodically through the operational life of the plant using such techniques as swabbing. Provision may also be allowed for interface with external decontamination systems to allow for further decontamination of waste arisings prior to the commencement of decommissioning. Evaluation of these options shall take the form of a BAT and ALARP assessment which will identify the preferred strategy for decontamination of the generic SMR-300.

26.5.3 CAE Summary

Preliminary evidence is provided in this subchapter which will ensure that decommissioning considerations are integrated into the design and overall decommissioning strategy. These considerations are consistent with RGP through aligning with the RSMDPs and the design for decommissioning guidance laid out within Appendix 1 of the ONR TAG on Decommissioning (NS-TAST-GD-026) [31] .

As such, there is confidence that Claim 2.3.2.2 will be fully demonstrated on completion of design activities thereby supporting overall demonstration that the Generic SMR-300 can be safely decommissioned (Claim 2.3.2) and that the design and safety assessment of the Generic SMR-300 considers the entire reactor lifecycle (Claim 2.3).

26.6 DISPOSAL ROUTES AND STORAGE

Claim 2.3.2.3: Credible disposal routes and storage facilities are (or will be available) prior to disposal for all decommissioning wastes.

The strategy for management of radioactive waste for the power plant informs the decommissioning strategy through adherence to the waste management hierarchy, application of BAT and the IWS. This section demonstrates the interface between Radioactive Waste Management and Decommissioning and how that interface will be managed to achieve Claim 2.3.2.3.

26.6.1.1 Waste Management Hierarchy

The waste management hierarchy establishes the priority order for the management of radioactive waste arisings based upon the environmental impacts of the waste. Figure 1 below highlights the radioactive waste management hierarchy:

Figure 1: Radioactive Waste Management Hierarchy [31]

As can be seen from Figure 1 above, the preferred approach for management of radioactive waste is to prioritise prevention of waste generation so far as is achievable and minimisation of waste generation where prevention is not achievable. By planning decommissioning activities strategically to control and minimise resource use, this can help to minimise the overall inventory of radioactive decommissioning waste arising from the power plant.

26.6.1.2 Radioactive Waste Management Principles

The ONR SAPs establish the basic principles for radioactive waste management within the UK. The relevant SAPs to Radioactive Waste Management are discussed within PSR Part B Chapter B13 [5] and PER Chapter 1 [12].

In addition, the relevant RSMDPs for radioactive waste management taken from the Radioactive Substances Regulations (RSR) are discussed within Chapter 1 of the PER [12].

One of the key principles for the management of radioactive waste from an environmental perspective is the application of BAT throughout the design of the power plant. The approach and application of BAT demonstration is covered separately within a dedicated report [55].

26.6.1.3 Integrated Waste Strategy

The IWS will be developed during Step 2 and summarised in a future revision of the SSEC. The IWS will outline the strategy for the management of all waste arisings from the generic SMR-300 from all phases of the power plant's lifecycle from construction through to decommissioning, recognizing that volumes and types of waste during decommissioning phases will vary.

Within this strategy the approach to optimising the waste management for all waste shall be described and all waste streams identified. Additionally, the actions required to improve the overall waste management strategy will be highlighted within the IWS. The IWS will be developed during Step 2 of this GDA as a supporting document.

26.6.1.4 Disposability Assessment

A disposability assessment is required for reactor new build projects to demonstrate that conditioned waste packages will be suitable and could be accepted in final disposal facilities in the UK [56]. The RP will seek advice from NWS regarding any risk to future disposability associated with expected waste arisings [57]. An Expert View process will be carried out to obtain a preliminary opinion from NWS experts [58].

Low Level Waste (LLW) waste produced during the operating stages of the plant is expected to be packaged on-site and, where necessary, sentenced to the Low Level Waste Repository (LLWR) or successor facility for treatment and disposal. Notwithstanding, maximum effort shall be given to utilisation of other suitable disposal routes such that inventory of LLW to be sent to the LLWR is minimised in line with the UK's regulatory framework. Therefore, there is a requirement to ensure that this waste is compliant with LLWR's or successor facility's Waste Acceptance Criteria (WAC). The RP will engage with NWS on their Agreement in Principle (AiP) process and gain their views on operational LLW packaging proposals, as well as identifying any challenges presented by any waste streams.

Any High Activity Waste (HAW) arising, which is made up of operational Intermediate Level Waste (ILW), decommissioning ILW and spent fuel (SF), will undergo long-term storage on-site until a Geological Disposal Facility (GDF) becomes available in the UK for such wastes, or be considered for disposal to the LLWR in the event they classify as ILW / LLW boundary wastes. Additionally, long-term on-site decay storage of the waste could be utilised until the waste is eligible for consignment to the LLWR. To comply with UK policy, it is required that any waste produced from an SMR is suitable for disposal in a GDF. Any significant risks or uncertainties concerning the wastes arising will be identified to allow the Expert View process to progress [57].

26.6.1.5 Reactor Decommissioning

During the reactor decommissioning stage, various types of radioactive waste will be unavoidably generated, especially in the process of decontamination and dismantling of structures, systems, and components (SSCs). According to worldwide decommissioning Operational Experience (OPEX), solid waste often accounts for the largest part of decommissioning waste during the plant decommissioning stage, mainly including:

- Contaminated concrete and piping, internal components during dismantling activities.
- Secondary waste generated during various decontamination and dismantling activities, e.g. decontamination of components, cutting of components, decommissioning waste treatment, or flushing of systems. This typically consists of liquid waste, gaseous waste, spent ion exchange resins, spent filters, and miscellaneous solid waste.

As systems and structures are dismantled, care shall be taken to avoid cross contaminating wastes by segregating waste streams. Liquid and gaseous waste will be managed by mobile facilities or existing waste management systems, such as Liquid Radioactive Waste (LRW), Gaseous Radioactive Waste (GRW) or HVAC systems. Solid waste will be classified in terms of Very Low Level Waste (VLLW), LLW and ILW, and will be managed by existing solid waste or mobile facilities with the same approach of operational waste. Radioactive Waste Management SSCs are described further in PSR Part B Chapter 13 [5].

Packaged VLLW and LLW will be sent to off-site facilities for treatment or final disposal in line with waste hierarchy. Packaged ILW will be stored on site if GDF is not available in the decommissioning stage of SMR-300.

26.6.1.6 Record Keeping and Knowledge Management

Identifying, preparing, updating, and retaining records relating to decommissioning is required to ensure compliance with SAP DC.6, and LC 25 – Operational Records, as well as satisfy the requirements of any future environmental permit conditions. The process for making and preserving the identified documentation will begin at the design phase and carry through the entire lifecycle of the plant. In particular, attention shall be given to the following documentation:

- As-built design documentation
- Site operational history.

- Incidents, accidents, and unusual occurrences.
- Radiological Surveys.
- Inventories of radioactive material (particularly the inventory at the end of routine operations).
- Environmental Monitoring Reports for the site, adjacent land and any monitored water pathways.
- The safety case.
- Interactions with any regulatory bodies.
- Examination, Inspection, Maintenance and Testing (EIMT) records.
- Decommissioning history including objectives of the decommissioning plan and the planned end-state for the site and how these were achieved through the decommissioning process.

Management and organisation of record keeping shall be described within the preliminary decommissioning strategy, which will be developed during Step 2.

26.6.2 Disposal Routes and Storage CAE Summary

An IWS and disposability assessment are required for full demonstration of Claim 2.3.2.3. Notwithstanding, there is confidence that all decommissioning wastes produced by the Generic SMR-300 will have credible disposal routes. Full demonstration of Claim 2.3.2.3 will be provided within Revision 1 of this PSR Chapter through development of the IWS and engagement with NWS on the disposability assessment.

26.7 DECOMMISSIONING FAULTS AND HAZARDS

Claim 2.3.2.4: Faults and hazards of Generic SMR-300 decommissioning are identified and assessed, and risks are shown to be capable of being ALARP.

The intent of this subchapter is to provide confidence that this Claim will be fully demonstrated in future safety report submissions, recognising that hazard identification for decommissioning hazards will be undertaken post-submission of Revision 1 of the PSR. To this end, this subchapter aims to present arguments regarding:

- Hazard identification process.
- Similarities with decommissioning regimes of currently operational Pressurised Water Reactors (PWR) of which hazards are anticipated to be similar.
- Management of hazards with regards to design for decommissioning.

26.7.1 Decommissioning Fault and Hazard Identification

As the expectation from the ONR is that safety cases are kept up to date during each stage of a facility's lifecycle [31], prior to the commencement of decommissioning, a post-defueling safety case is required. This could be done either by re-writing the safety case for decommissioning operations or updating the safety case to remove fuel related faults. Historically, licensees have opted for not re-writing the entire safety case for decommissioning but instead re-baselining the existing safety case with amendments being made as decommissioning projects are proposed. As such, the operational safety case should give a preliminary indication as to the hazards expected during decommissioning.

The design features associated with the SMR-300 which have been included to minimise radiation exposure will be covered with Part B Chapter 10 Radiological Protection of the PSR [7]. A preliminary fault schedule will be developed and presented within Part B Chapter 14 Design Basis Accident Analysis [59] of the PSR. Part B Chapter 22 Internal Hazards [60] will hold the discussion on hazards arising from within the plant boundary. Part B Chapter 21 External Hazards will hold the discussion around any hazards arising outside of the plant boundary [61][ref b21]. Through the operational life of the SMR-300, there will also be operational experience gained through EIMT activities which will inform the hazards anticipated for the decommissioning phase. For conventional hazards associated with the POCO phase and hazards associated with fire, these will be covered within Part B Chapter 12 Nuclear Site Health and Safety and Fire Safety [62].

26.7.2 Decommissioning Regimes of Currently Operating PWRs

In the UK, decommissioning is carried out under the same legislative framework as the preceding steps in the lifecycle. The general legal duties and principles of nuclear safety, nuclear site health and safety, nuclear safeguards, and nuclear security continue to apply during decommissioning. Consequently, the general advice provided in other TAGs remains relevant when a site or facility enters decommissioning.

Identification of well-established decommissioning hazards based on operational experience will give added confidence that the decommissioning hazards expected for the Generic SMR-300 are broadly in line with existing PWRs and therefore that the Generic SMR-300 can be safely decommissioned. The current PWR fleet in the UK will be decommissioned under existing regulatory frameworks. Looking at the current SMR 300 demolition waste estimates, there are no projected waste types or volumes that are not able to be treated or disposed of in the UK. The ILW to be generated by the SMR 300 will need a packaging and storage solution until the GDF is available.

Further, it should be noted that Holtec Decommissioning International, a subsidiary of Holtec International, the parent company of SMR, Limited Liability Company (LLC), are currently decommissioning nuclear power plants in the US. Any operational experience or lessons learned from these activities shall be considered during the design of the generic SMR-300.

26.7.3 Decommissioning Risk Reduction

The design features discussed within Section 26.5 which are to be included with the Generic SMR-300 design facilitate the reduction of risks, primarily those concerning personnel dose uptake associated with decommissioning, to ALARP.

26.7.4 CAE Summary

Claim 2.3.2.4 has been demonstrated to the extent possible for this revision of the PSR. Decommissioning hazard identification and subsequent assessment will be required following defueling and throughout the various decommissioning phases; however, decommissioning specific hazards will not be identified prior to submission of Revision 1 of the PSR.

Nevertheless, the operational safety case of the generic SMR-300 should provide preliminary indication of the potential decommissioning hazards and can be used as a baseline for the decommissioning safety case when required. The work that will be undertaken to incorporate decommissioning considerations into the design as early as possible will help identify the risks and hazards associated with decommissioning and input into the decommissioning strategy.

Additionally, it is expected that OPEX and lessons learned from decommissioning the existing fleet of PWRs will become available to support decommissioning of the generic SMR-300, supporting further reduction of risks ALARP.

26.8 CHAPTER SUMMARY AND CONTRIBUTION TO ALARP

This subchapter provides an overall summary and conclusion of the Decommissioning Approach Chapter and how this Chapter contributes to the overall demonstration of ALARP for the generic SMR-300. PSR Part A Chapter 5 [63] sets out the overall approach for demonstration of ALARP and how contributions from individual Chapters are consolidated.

This subchapter therefore consists of the following elements:

- Technical Summary;
- ALARP Summary
  - Review against Relevant RGP;
  - Demonstration Against Risk Targets;
    - Evaluation of Risk (where applicable);
  - Risk Reduction Options;
  - GDA Commitments and Forward Actions.
- Conclusion.

A review against these elements is presented below under the corresponding headings.

26.8.1 Technical Summary

PSR Chapter B Part 26, Revision 0 demonstrates that the Decommissioning Approach will meet the high-level Claims of the SSEC and that this approach can be substantiated at Pre-Construction Safety Report (PCSR) stage. This is demonstrated through the chapter claim:

Claim 2.3.2: The Generic Holtec SMR-300 can be safely decommissioned. Presently, a decommissioning strategy for the generic SMR-300 has not been developed. A preliminary decommissioning strategy will be developed during Step 2 to demonstrate that the Generic SMR-300 is capable of being decommissioned as soon as is reasonably practicable in line with UK policy.

The design standard for decommissioning outlines good practice which should be considered during the design phase to facilitate decommissioning. These design considerations align with UK RGP as defined in NS-TAST-GD-026 [31] and the RSMDPs [33] .

Through formation of a preliminary decommissioning strategy in line with UK policy, demonstration of inclusion of design for decommissioning principles within the Generic SMR-300 design, engagement with NWS on the disposability assessment and identifying all foreseen decommissioning wastes within the IWS, there is great confidence that the Generic SMR-300 can be safely decommissioned. Furthermore, by committing to carry out hazard identification and assessment it will ensure that the risks arising from decommissioning are appropriately managed.

26.8.2 ALARP Summary

26.8.2.1 Demonstration of RGP

The decommissioning documentation produced by Holtec International has been produced in line with the US regulatory requirements laid out within 10 CFR 50 [64] as well as Regulatory Guide 1.202 [65] relating to decommissioning cost estimation for nuclear power plants. A gap analysis has been undertaken (see Subchapter 26.30) which has demonstrated that regulatory requirements and decommissioning principles identified for incorporation in the design are in line with UK RGP, specifically the ONR TAG for decommissioning (NS-TAST-GD-026) [31].

While the US has differing waste categories for the anticipated decommissioning wastes than the UK, adherence to the waste management hierarchy, development of the IWS and engagement with NWS on the disposability assessment shall ensure that all foreseen decommissioning wastes have a suitable disposal route within the UK. There is presently a gap concerning the interim storage of ILW wastes on site which is not required within the US regulatory context. Further details on how this will be managed will be presented in Revision 1 of the PSR.

While the decommissioning strategy for the Generic SMR-300 has not yet been produced, it will be developed in line with UK RGP, namely the UK policy framework for managing radioactive substances and nuclear decommissioning [48]. The decommissioning strategy shall incorporate lessons learned where available from the US NRC, NEA, IAEA [66] and WENRA [38]. Some examples are the Decommissioning Lessons Learned database on the NRC website [40], and NEA No. 6924 [41].

It should be noted that Holtec Decommissioning International, a subsidiary of Holtec International, the parent company of SMR, LLC, are currently decommissioning nuclear power plants in the US. Any operational experience or lessons learned from these activities shall be considered during the design of the generic SMR-300.

26.8.2.2 Demonstration Against Risk Targets

The numerical targets against which the demonstration of ALARP is considered can be found in PSR Chapter A2 [4]. The Decommissioning Approach will contribute to the demonstration of ALARP by comparison against the risk targets in two ways:

- By enabling safe decommissioning in normal operations and thereby contributing to achieving Targets 1-3;
- By ensuring safe decommissioning is possible in accident scenarios, achieving Targets 4-9.

Risks above the Basic Safety Level (BSL) are not acceptable. Risks below the BSL require a demonstration of ALARP proportionate to the level of risk. The Basic Safety Objective (BSO) represents the modern safety standards and expectations against which the UK SMR 300 will be assessed.

26.8.2.2.1 Evaluation of Risk

As hazard identification for the decommissioning of the Generic SMR-300 will not be conducted prior to Revision 1 of this PSR Chapter, it is not possible to quantitatively demonstrate the risks associated with decommissioning or how those contribute to the risk targets discussed above. This activity is required to support production of the PCSR.

Nevertheless, preliminary evidence has been provided that demonstrates risk will be reduced ALARP through incorporation of decommissioning design considerations that align with UK RGP and the future production of a preliminary decommissioning strategy that will also apply BAT.

26.8.2.3 Risk Reduction Options

This is a placeholder to identify and review relevant Position Papers and Design Decision Papers with a view to demonstrate which option(s) is/are ALARP.

It will summarise those option evaluations, and it will briefly explore if other risk reduction options have or could be considered and either:

- Present the ALARP argument for why those options have not been implemented.
- Present the ALARP argument for why those options will be implemented in future.
- Create a Forward Action to consider the option(s) at some future point (noting this still must be a point where a meaningful design improvement could be made).

The process for the assessment of risk reduction options is presented in Holtec SMR-300 Generic Design Assessment Reference Design Process and GDA Prospective Design Change Register [67]. Part A Chapter 5 of this PSR ALARP Summary [63] considers the holistic risk-reduction process for the Generic SMR-300.

26.8.2.4 GDA Commitments and Forward Actions

There are no GDA commitments identified for Chapter B26 Decommissioning Approach.

Forward Actions have been collated and are managed via the process described in PSR Part A Chapter 4, Lifecycle Management of Safety and Quality Assurance [68]. PSR Chapter A5 ALARP Summary [69] describes the contribution of the forward actions to the ALARP argument.

26.8.3 Conclusion

The conclusion of this Chapter of the PSR is that:

- The Chapter Claims identified have been met to a maturity aligned with a preliminary safety report. Further claims, arguments and evidence will be presented in due course as the design develops.
- The Preliminary Decommissioning Strategy is being developed in accordance with the UK's decommissioning policy and therefore will meet UK RGP.

- Design for Decommissioning principles meet UK RGP and will be incorporated into the overall Generic SMR-300 design, providing confidence that decommissioning risks will be reduced ALARP.
- Disposal Routes and Storage methods will be laid out as part of development of the IWS. This will be supplemented by a disposability assessment conducted by NWS.
- Hazard identification that will be undertaken as part of developing the SSEC will provide preliminary indication of the hazards expected for decommissioning. This will be supplemented in future by OPEX from decommissioning of the existing fleet of PWRs. Incorporation of decommissioning considerations into design will aid in reducing hazards.

Part A Chapter 5 of this PSR ALARP Summary [63] concludes that it can be demonstrated that the Generic SMR-300 reduces risks to ALARP and that the Fundamental Purpose of the SSEC has been fulfilled.

26.9 REFERENCES

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26.10 LIST OF APPENDICES

Appendix A Decommissioning Approach CAE Route Map

A summary of the SSEC claims for the decommissioning approach is presented in Table 6Table 6.

Table 6: Chapter B26 CAE Route Map

Overarching SSEC Claim	Chapter Claim	Chapter Sub-Claims	Chapter Section
Claim 2.3 - Lifecycle The design and safety assessment of the Generic Holtec SMR-300 considers the entire reactor lifecycle.	**Claim 2.3.2 - Decommissioning** The Generic Holtec SMR-300 can be safely decommissioned.	**Claim 2.3.2.1** The decommissioning strategy for the Generic Holtec SMR-300 shall enable decommissioning to be safely undertaken as soon as is reasonably practicable.	26.4 Decommissioning Strategy
		Claim 2.3.2.2 The Generic Holtec SMR-300 incorporates features that facilitate decommissioning and can be decommissioned using current, proven technology.	26.5 Design for Decommissioning
		Claim 2.3.2.3 Credible disposal routes and storage facilities are available (or will be available) prior to disposal for all decommissioned wastes.	26.6 Disposal Routes and Storage
		Claim 2.3.2.4 Faults and hazards of Generic SMR-300 decommissioning are identified and assessed, and risks are shown to be capable of being ALARP.	26.7 Decommissioning Faults and Hazards