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# PSR Part B Chapter 13 Radioactive Waste Management

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This record does not contain commercial or business sensitive information.

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## Revision Log

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## 13.1 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, commissioned, operated, and decommissioned on a generic site in the United Kingdom (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 [1].

The fundamental purpose is achieved through the fundamental objective of the PSR, which is to present and justify 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) [1].

Part B Chapter 13 of the PSR presents the Claims, Arguments and intended Evidence (CAE) for the design of Radioactive Waste Management Structures, Systems and Components (SSCs) and provisions that underpin the design of the generic SMR-300 for the operational phase of the reactor. This ensures safety functions and measures are delivered and radiation exposure and release of radioactive material are minimised So Far As Is Reasonably Practicable (SFAIRP). This will support maintaining an appropriate radioactive waste management strategy consistent with the lifecycle phase.

This chapter focuses primarily on Nuclear Liabilities Regulations (NLR) aspects, which is within the jurisdiction of the Office for Nuclear Regulation (ONR). By contrast, the Preliminary Environmental Report (PER) Chapter 1 Radioactive Waste Management Arrangements (RWMA) [2] is the focus of the Environment Agency (EA) and Natural Resources Wales (NRW).

### 13.1.1 Purpose and Scope

The overarching SSEC claims are presented in Holtec SMR GDA PSR Part A Chapter 3 Claims, Arguments and Evidence [3].

This chapter covers the codes, standards and guidance associated with the provisions for radioactive waste management and the design of the above mentioned SSCs (sub-chapter 13.4), the design of the SSCs with respect to reducing risk to ALARP (sub-chapter 13.5), the strategy for managing radioactive waste throughout the entire reactor lifecycle (sub-chapter 13.6) and the specific considerations applicable to the Nuclear Liabilities Regulations aspects for radioactive waste management (sub-chapter 13.6.2). Finally, sub-chapter 13.7.1 provides a technical summary of how the claims for this Chapter have been achieved, together with a summary of key contributions from this chapter to the overall ALARP. Sub-chapter 13.7.4 also discusses any GDA commitments that have arisen.

No novel aspects have been identified in the radioactive waste management SSCs or associated operational activities within the scope of this document, with respect to their application in the UK. However, subject to further design development and down-selection study, the preferred packaging solution for ILW may involve the use of packages that, while well-established internationally, are considered novel disposal packages within the UK. Additional information on the disposability of radioactive waste can be found within 13.6.2.7.

The Independent Spent Fuel Storage Installation (ISFSI) is excluded from the scope of this Chapter [4] and is within scope of PSR Part B Chapter 24 Fuel Transport and Storage [5]. Furthermore, internal structures, equipment supports and the Reactor Auxiliary Building (RAB) are excluded from the scope of this chapter; the latter of which forms part of the scope of PSR Part B Chapter 20 Civil Engineering [6].

A master list of definitions and abbreviations relevant to all PSR Chapters can be found in PSR Part A Chapter 2 General Design Aspects and Site Characteristics [7].

### 13.1.2 Assumptions

Assumptions which relate to this topic have been formally captured in the Commitments, Assumptions and Requirements process [8]. Further details of this process are provided in PSR Part A Chapter 4 Lifecycle Management of Safety and Quality Assurance [9].

There are no assumptions raised in relation to PSR Part B Chapter 13. However, assumptions related to radioactive waste management are raised within PER Chapter 1 [2] which are relevant to this PSR Chapter.

### 13.1.3 Interfaces with other SSEC Chapters

As with all safety case topic areas, radioactive waste management both influences and is influenced by other topic areas. Key interfaces are described below.

PSR Part B Chapter 4 Instrumentation and Control (I&C) Systems [10] concerns the electronic systems and instruments design of the generic SMR-300. PSR Part B Chapter 6 Electrical Engineering [11] concerns the electrical SSCs of the generic SMR-300. These chapters will interface with radioactive waste management as the radioactive waste management systems will incorporate some of these designs and SSCs.

PSR Part B Chapter 5 Reactor Supporting Facilities [12] contains descriptions of the auxiliary and steam and power conversion systems. Radioactive waste management SSCs receive inputs from some of these systems – including the Chemical and Volume Control System (CVC) and the Spent Fuel Pool Cooling System (SFC).

PSR Part B Chapter 9 Description of Operational Aspects and Conduct of Operations [13] concerns the operational requirements of the generic SMR-300 such as Examination, Inspection, Maintenance and Testing (EIMT). EIMT of the radioactive waste management systems will be required to allow the system to deliver its relevant functions throughout the operational life of the generic SMR-300.

PSR Part B Chapter 10 Radiological Protection [14] concerns the radiological protection of workers and the public of the plant as well as the public. During the design phase, design for radioactive waste management systems should be considered to reduce the dose to operators during the operational phase of the plant.

This chapter also interfaces with the PER, particularly PER Chapter 1 Radioactive Waste Management Arrangements (RWMA) [2] which is a key interfacing topic area. While this chapter primarily addresses the expectations of the ONR, PER Chapter 1 focuses on the requirements of the EA. Nonetheless, this PSR chapter includes a high-level consideration of EA requirements, with cross-references to PER Chapter 1 [2] where applicable.

In addition, this chapter interfaces with PER Chapter 6 Demonstration of Best Available Techniques (BAT) [15], where the environmental based claims are held and substantiated. Further discussion of the environmental claims that interface with this PSR chapter are provided in sub-chapter 13.7.3.

PSR Part B Chapter 14 Design Basis Accident Analysis [16] concerns accident scenarios of the generic SMR-300 and PSR Part B Chapter 16 Probabilistic Safety Analysis [17] concerns probabilistic safety analysis of the generic SMR-300. Both of these chapters assess identified fault sequences associated with the generic SMR-300 plant. A Hazard and Operability Study (HAZOP) 1 [18] was conducted in GDA for the radioactive waste management SSCs but a detailed Design Basis Accident Analysis (DBAA) and PSA has not yet been carried out for the radioactive waste management systems. DBAA and PSA will be developed for the radioactive waste management systems to support the Pre-Construction Safety Report (PCSR).

PSR Part B Chapter 17 Human Factors [19] concerns human factors which will have input to all systems of the generic SMR-300. There is an interface with human factors considerations relating to the operation and maintenance of the radioactive waste management systems.

PSR Part B Chapter 19 Mechanical Engineering [20] concerns the SSCs that support the generic SMR-300 plant safety and mechanical claims. The mechanical design of the SSCs will have influence on the on the radioactive waste management systems.

PSR Part B Chapter 20 Civil Engineering [6] concerns Civil Engineering. The construction of the generic SMR-300 from a Civil Engineering perspective will influence the radioactive waste management systems SSCs incorporation into the generic SMR-300.

PSR Part B Chapter 23 Reactor Chemistry [21] covers reactor chemistry. This has relevance to radioactive waste management systems as the reactor chemistry will influence the quantity and characteristics of the wastes generated as well as the final waste forms produced.

PSR Part B Chapter 26 Decommissioning Approach [22] concerns the decommissioning approach and strategy of the generic SMR-300, as well as the application of design for decommissioning principles. This will be relevant to this chapter as it will include the future decommissioning of the radioactive waste systems.

# 13.2 DESCRIPTION OF RADIOACTIVE WASTE MANAGEMENT SSCS

This section provides a summary description of the radioactive waste management SSCs that are within the scope of this PSR chapter. Additional details concerning the buildings housing these systems are presented within PSR Part B Chapter 20 [6]. As part of design development of the SMR-300, the functional requirements of the Radioactive Waste Building (RWB) have been combined into the Reactor Auxiliary Building (RAB). The impact of combining the RAB and the Radioactive Waste Building (RWB) with respect to the radioactive waste management SSCs are detailed below within the respective system descriptions.

## 13.2.1 Radioactive Drain System

The design definition of the Radioactive Drain System (RDS) was not included in the GDA Design Reference Point [23] (DRP) due to ongoing design development. The system's function is to collect the liquid effluent arisings from the generic SMR-300 and direct them to the correct location for treatment. This includes segregation at source of the liquid effluents.

## 13.2.2 Liquid Radwaste System

### 13.2.2.1 System Overview

The LRW is responsible for the collection, treatment and release of radioactive liquid wastes generated by the plant during all operations.

The main waste inputs to the LRW are the wastes collected in the RDS and CVC. These wastes are segregated at source in the RDS and the CVC before being transferred to the LRW for processing. The LRW utilises a combination of filtration and ion exchange to treat collected liquid waste.

Discharge of effluent to the environment shall be subject to procedural and administrative controls. The details of these controls are to be defined at the site-specific stage. The sampling and monitoring arrangements required for all discharges are summarised within PER Chapter 5 Approach to Monitoring and Sampling [24].

Additional design information can be found in the System Design Description (SDD) for LRW [25], the tank sizing calculations [26] and the LRW Piping and Instrumentation Diagram (P&ID) [27].

### 13.2.2.2 LRW System Boundaries

Table 1 below presents the key systems that interface with the LRW [25].

**Table 1: Summary of LRW Interfaces**

| System | | Function |
|---|---|---|
| CAI | Compressed and Instrument Air System | The CAI provides an air supply to control valves with diaphragm actuators. |
| CRS | Circulating Water System | Blowdown from the CRS is used as the water source to facilitate permitted discharges to the environment. |
| CVC | Chemical and Volume Control System | Letdown from the CVC is directed to the LRW for collection, storage, and processing. |
| DWS | Demineralized Water System | DWS provides rinse water for backwashing the ion exchangers. |

| System | | Function |
|---|---|---|
| ICPS | I&C Power Distribution System | The Air Operated Valves (AOVs) are powered by the non-safety portion of the ICPS. |
| LVE | Low Voltage Alternating Current (AC) Distribution System | Pump motors are powered by the non-safety portion of the LVE. |
| PCS | Plant Control System | Control system for the non-safety portions of the LRW. |
| PSL | Primary Sampling System | Samples will be collected and analysed via the primary sampling system. |
| RCV | Radiologically Controlled Area Heating, Ventilation and Air Conditioning (HVAC) System | LRW tanks are vented to the RCV. |
| RDS | Radioactive Drain System | The RDS collects liquid wastes from equipment and floor drains and transfers them to the LRW waste holdup tanks for processing. |
| SRW | Solid Radwaste System | Spent resin from the ion exchangers is transferred to the SRW for storage and processing. |

#### 13.2.2.3 LRW System Description

The LRW is designed to protect plant personnel from radiation exposure as well as minimising the radioactive releases to the environment.

Waste arisings treated by the LRW comprises liquids from low and high conductivity drains in the RDS, liquids from the RAB chemical drains in the RDS, and liquids from CVC letdown. Non-radioactive wastes are excluded from LRW system scope and will instead be handled and processed by other systems. It should be noted that non-aqueous liquid waste (e.g. oily waste) is managed by the SRW (see sub-chapter 13.2.4).

The LRW collects, processes, and stores the radioactive liquid waste arisings produced throughout the plant during normal operations, including refuelling, plant startup and shutdown and maintenance operations, as well as during Anticipated Operational Occurrences (AOOs). The LRW system is common to units 1 and 2 and all liquid waste will be processed through the equipment presented.

The LRW consists of tanks, pumps, filters, and demineralisers which process radioactively contaminated waste. If the waste collected in the waste holdup tanks is determined through sampling to be incompatible with the installed plant equipment, provisions are in place to enable connection to external temporary mobile processing equipment.

Prior to processing, liquid wastes are segregated by high and low conductivity within the RDS and CVC for collection and processing. By segregating the different arisings, this will allow for more effective processing thereby minimising the quantity of solid radioactive waste produced by the system. This segregation of wastes relates to the EA's Radioactive Substances Management: Generic Developed Principles (RSMDPs) through RSMDP8 – Segregation of wastes. This RSMDP specifies that segregation of radioactive substances should be addressed when designing new facilities. Inclusion of the segregation within the RDS and CVC demonstrates that this has been considered within the SMR-300 design.

The LRW is designed with sufficient redundancy, flexibility, and capacity to ensure that functional requirements of the system are met under any expected plant conditions. The waste holdup tank pumps are cross-connected for operational flexibility and expected maintenance. The monitoring tanks can be used between subsystems in the LRW for increased capacity, if needed.

#### 13.2.2.3.1 Effluent and Waste Collection

##### 13.2.2.3.1.1 Waste Collection

The wastes collected within the LRW consist of potentially contaminated RDS floor drains, borated reactor-quality water, and any chemical wastes collected throughout the plant. These wastes include effluent from the CVC system which through sampling has been deemed unsuitable for re-use, residual water transferred from the spent resin from the SRW, various potentially contaminated building RDS floor drains and sumps, general chemical wastes, and other miscellaneous drains.

RDS floor drains inside containment and the spent fuel pool liner leakage are collected in the RDS containment floor sump [27]. Degasification takes place within the CVC prior to entry into the LRW system, but a hydrogen monitor is present on each tank to detect hydrogen in the LRW.

Wastes are segregated due to high and low conductivity within the RDS. Within the LRW system, waste is transferred directly to the waste holdup tanks. Waste holdup tank pumps are provided to recirculate or transfer the contents of the waste holdup tanks to the desired destination. If one waste holdup tank pump is unavailable, a cross connection is provided to allow the backup tank pump to be used for processing.

There are also chemical wastes produced throughout the plant. Chemical wastes include inputs from laboratories and other small volume sources. These wastes are also collected within the waste holdup tanks. Provisions are included to transfer the tank contents to be processed through the LRW equipment. The chemical wastes may be discharged if processing is not required or may be processed through temporary mobile equipment if they are incompatible with installed equipment.

##### 13.2.2.3.1.2 Effluent Collection

Effluent collection is undertaken via the waste holdup tanks in the LRW system. There is an interface between the LRW and CVC to allow CVC letdown to be processed through the LRW processing equipment, if required. Further information on the CVC is available in the SDD for CVC [28].

#### 13.2.2.3.2 Processing Equipment

The effluent and waste from the holdup tanks are combined in a common pipe manifold into the inlet of the LRW processing equipment. The abatement equipment used to process the arisings is anticipated to consist of:

- Prefilter.
- Activated Carbon Filter.
- Ion Exchange Columns.
- After filter.

Four processing vessels are provided. One activated carbon filter is followed by three ion exchangers with the last two operating in a series carousel. The media will be selected by the plant operator to optimise system performance. The activated carbon filter acts as a deep-bed filter and removes residual oil from RDS floor wastes and other non-ionic contaminants from CVC letdown or other RDS subsystems. The activated carbon filter can be bypassed for cleaner waste streams that do not require this processing. The three ion exchanger beds are identical vessels. The ion exchangers are selectively loaded with resin, depending on plant conditions and waste processing demands. The order of the last two ion exchangers can be interchanged to provide complete usage of the ion exchange resin. This optimises resin utilisation and minimises solid waste. The ion exchange vessels are stainless steel, vertical, cylindrical pressure vessels with inlet and outlet process nozzles and connections for resin addition, sluicing, and draining. They are designed with pressure relief valves to prevent over pressurisation.

Any of the filters and vessels can be manually bypassed to add additional flexibility in operation and maintenance requirements. Additional connections are provided for loading fresh resin, and to transfer spent resin to the SRW for storage and processing.

#### 13.2.2.3.3 Effluent Monitoring and Discharge

After the effluent has been appropriately treated, it is pumped to the monitoring tanks using the waste holdup tank pumps. These tanks are provided to allow for storage of the treated effluents and wastes for sampling prior to discharge. The contents of these tanks can be re-circulated and sampled. Based on the sampling results, the tank contents are discharged to the environment or reprocessed. Direct discharges to the environment will be minimised.

Where environmental discharge is required, the effluent is pumped to the CRS using the monitoring tank pumps prior to direct discharge. Effluent radiation monitoring is installed in the outfall line, upstream of the interface with the CRS. Effluent release to the outfall is automatically isolated upon detection of high radiation by the effluent monitor. Direct operator intervention is required to restart the release to the outfall.

### 13.2.2.4 LRW System Operation

The LRW is required to operate during all normal operating conditions, including refuelling and maintenance outages. The system operation for the LRW is controlled via the PCS for all non-safety related equipment. Normal operations as well as AOO are summarised below.

#### 13.2.2.4.1 LRW Operational Requirements

The operational requirements for the LRW can be found below:

- Alternative routings for chemical waste in the event of high radioactivity content shall be: (1) processed through LRW filter and ion exchangers, or (2) processed through a temporary mobile equipment skid.
- The LRW shall be designed to provide connections for the transfer of wastewater used for handling spent resin into the waste holdup tanks either for processing or routing to the temporary mobile equipment skid.
- A minimum flow of water for liquid radioactive waste releases to the outfall shall be required to permit discharges to ensure the permitted discharge is able to be adequately transported to the discharge point.

#### 13.2.2.4.2 LRW Normal Operation

During normal operation, one waste holdup tank receives input while the other waste holdup tank is in standby mode or feeding the processing system. An alarm alerts the operator that a tank is ready for processing. Once the tank level reaches the pre-determined threshold, the system automatically realigns so that the standby tank becomes the receiving tank. Hydrogen detectors are provided to monitor the atmosphere in the waste holdup tanks to ensure that if any explosive gases are present, it will be vented to the RCV.

When a waste holdup tank is full, the contents are recirculated before transfer for processing. The last ion exchanger column provides a polishing function and prevents radioactivity breakthrough to the monitoring tank in the event the upstream resin beds are exhausted. This allows the full capacity of the upstream resin beds to be used, reducing the amount of spent resin that is generated. When one of the last two ion exchangers has been replenished, the fresh unit is then brought online as the downstream unit.

The processed waste is collected in a monitoring tank. If the tank level reaches the pre-determined threshold, the system automatically realigns to direct the effluent to a standby tank. Based on analytical results, the contents of the monitoring tank can be released to the environment or sent to the waste holdup tanks for reprocessing.

The LRW is designed to provide alternate or redundant processing paths to ensure plant availability and continuous waste receiving capability. Cross-connections are provided between the LRW subsystems to allow various processing routes based on plant and chemistry needs.

#### 13.2.2.4.3 LRW Startup Operation

There is no change in operation of the LRW during plant start up.

#### 13.2.2.4.4 LRW Shutdown Operation

The LRW is sized to accommodate the increased radioactive waste volumes during shutdown operations. There is no system impact other than additional LRW processing requirements.

#### 13.2.2.4.5 LRW Refuelling Operation

The LRW is sized to accommodate the increased radioactive waste volumes during refuelling operations. There is no system impact other than additional LRW processing requirements.

### 13.2.2.5 Combination of RWB and RAB on LRW

As part of the development of the generic SMR-300 design, the decision was made to absorb the RWB functions into the RAB. Consequently, the radioactive waste management systems, including the LRW, GRW and SRW SSCs, are now housed within the RAB rather than in a separate, dedicated facility. A design decision paper [29] has been produced to outline the impacts of this integration. These are summarised below for the LRW:

- The elimination of the RWB will remove any requirements for underground utilities between the RAB and RWB that can potentially degrade and/or leak, thereby greatly reducing environmental risk. For example, piping, liquid transfer lines, process lines, and radioactive waste floor drains.

- The consolidation of the LRW system within the lowest elevation of the RAB reduces the potential safety impact of flooding from a system tank rupture. This arrangement presents a lower safety risk compared to the system's previous location in the RWB. Additionally, it allows for other systems and components to be routed to areas that allow for their consolidation thereby minimising long piping runs.
- The consolidation eliminates the requirement to transfer liquid waste between two separate buildings.
- Any liquids associated with AOOs or design basis accidents will continue to be processed via the LRW filter and demineralisation system located on the 0' Elevation of the RAB instead of the 0' Elevation of the RWB. Therefore the dose impact on the Main Control Room (MCR) and/or the Remote Shutdown Facility (RSF) will remain unchanged.
- The additional space on the lower elevation allowed the relocation of the LRW's waste holdup tanks, currently on -21' Elevation, to -42' Elevation (lowest plant level). From an operational benefit, this promotes natural (gravity) drainage from the RDS and simplifies water movement from CVC holdup tanks on -38' Elevation to LRW.
- Consolidation of the liquid waste processing will result in other areas experiencing more efficient pipe run layouts.
- The consolidation of the liquid waste processing equipment into one single area, doubles the number of waste holdup tanks available to the system.[1] This allows for greater operational flexibility without appreciably increasing overall capacity. This flexibility is critical for instances of high conductivity water or higher radioactive water collection for appropriate processing without restricting plant operations.

### 13.2.3 Gaseous Radwaste System

#### 13.2.3.1 System Overview

During plant operation, radioactive fission and activation products are generated within the reactor core. These include noble gases such as xenon and krypton, and halogens such as iodine, which are normally retained within the fuel matrix and cladding. However, in the event of fuel cladding defects, these gaseous fission products may be released into the reactor coolant.

Hydrogen gas is routinely added to the Reactor Coolant System (RCS) during operation to scavenge oxygen and minimise corrosion. Prior to maintenance and refuelling outages, the hydrogen inventory must be removed from the RCS. This is achieved via the CVC, through which both hydrogen and radioactive gaseous wastes are routed. These gases are collected in the CVC effluent holdup tanks and volume control tanks, then processed to reduce their radioactivity levels in accordance with offsite release limits. Excess hydrogen is also vented during this process.

Gaseous effluents from both SMR-300 units are treated within a shared GRW, providing a centralised approach to gaseous waste management.

The GRW is designed to process gaseous waste generated during all modes of plant operation and is located in the RAB. The primary waste gas inputs are the CVC effluent holdup

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[1] [REDACTED]

tanks and volume control tanks. The gases processed by the GRW primarily consist of hydrogen and nitrogen, which act as carrier gases for the relatively small amounts of fission gases.

The GRW uses the principle of decay storage to treat the gaseous waste arisings from the generic SMR-300. The GRW Gaseous Decay Tanks (GDTs) store radioactive gases to provide sufficient decay prior to its release into the environment. The system provides holdup for the decay of radioisotopes and transfers the processed gaseous effluent to the RAB HVAC system for monitored releases. Gas from the decay tanks can also be recycled to the effluent holdup tanks and volume control tanks for use as a cover gas to preclude air intrusion.

Throughout the GRW, there are several interfaces with the Nitrogen Supply System (NISS). This provides several functions: it provides backup to the cover gas system, maintains the pressure in the system and ensures that the hydrogen concentration within the system never reaches the lower flammability limit.

Additional design information can be found in the SDD for GRW [30] and GRW P&ID [31].

### 13.2.3.2 System Boundaries

Table 2 below presents the key systems that interface with the GRW [30].

**Table 2: Summary of GRW Interfaces**

| System | | Function |
|---|---|---|
| CAI | Compressed and Instrument Air System | The CAI provides an air supply to control valves with diaphragm actuators. |
| CCW | Component Cooling water | The CCW supplies chilled water to the shell side of heat exchanger, in the GRW gas compressor. |
| CVC | Chemical and Volume Control System | CVC waste gas arisings requiring treatment are primarily transported to the GRW. |
| ICPS | I&C Power Distribution System | The AOVs are powered by the non-safety portion of the ICPS. |
| NISS | Nitrogen Supply System | The NISS supplies nitrogen throughout the GRW to provide system purging and backup to the waste gas vent header for cover gas. |
| PCS | Plant Control System | The PCS monitors and controls the GRW equipment and components with non-safety functions. GRW instrumentation provides signals to PCS. |
| RAB HVAC System | Reactor Auxiliary Building HVAC System | The processed gaseous effluents will be vented to the atmosphere through the RAB HVAC System. A radiation monitor will be placed at the discharge vent with an interlock/ permissive to automatically close the discharge isolation valve in the GRW in the event of high radiation levels. |
| RCV | Radiologically Controlled Area HVAC System | The RCV provides continuous ventilation air to remove potentially flammable and/or radioactive gases from the spaces containing GRW equipment. |
| RMS | Radiation Monitoring System | The RMS provides radiation monitoring of the effluents within the GRW. |

### 13.2.3.3 System Description

The GRW primarily collects gaseous waste arisings from the CVC volume control tank and CVC effluent holdup tanks. The system provides holdup of the radioactive species present in the gas before processing, monitoring, and discharging.

Two redundant waste gas compressors for the dual unit site are provided for removal of gases from equipment that contains or can contain radioactive gases. Each compressor package has a closed loop water circuit that supplies the seal ring, and which separates the liquid water and gas prior to the gas leaving the package. The seal water also cools the gas as it is compressed. The heat of compression is removed by a liquid/liquid heat exchanger in the closed loop. The heat exchanger is cooled by the CCW. A dropout tank is used to remove residual moisture that condenses in the piping downstream of the compressors and upstream of the GDTs.

Six welded GDTs[2] for the dual unit site are provided to contain compressed waste gases (hydrogen, nitrogen, and fission gases). These GDTs are located in the RAB. After sufficient decay has occurred, these gases may be released at a controlled rate to the atmosphere through the auxiliary building exhaust vent. All discharges to the atmosphere will be monitored for radioactivity and automatically terminated if the preset threshold for the release is exceeded.

The increase in the number of GDTs for the GRW from four to six offers several potential operational and safety advantages. Notably, the additional tanks have the potential to enhances system redundancy and flexibility, allowing maintenance or isolation of individual tanks without interrupting GRW system functionality. As the GRW design matures, the configuration will be enhanced to ensure the design remains proportional to risk and that systems do not create unnecessary complexity.

### 13.2.3.4 System Operation

The GRW is required to operate during all normal operating conditions, including refuelling and maintenance outages. The system operation for the GRW is controlled via the Plant Safety System (PSS) for any safety related equipment and the PCS for all non-safety related equipment. Normal and abnormal operations are summarised below.

A summary of the operations associated with normal operation of the GRW as well as how the GRW reacts to abnormal operation can be found below.

#### 13.2.3.4.1 Normal Operation

During normal operation, the GRW receives waste gases from the CVC effluent holdup tanks and volume control tanks. Gases from the gaseous sampling system are also discharged into the GRW. Most gas input is expected to originate from the effluent holdup tanks due to gas displaced during boration and dilution of the RCS.

Gas enters the GRW through the vent/cover gas header. The gas then enters one of two compressors, which compresses the gas for storage. Compressed gas can be stored in any of six decay tanks. Each decay tank includes provisions for its contents to be sampled and analysed. The contents of each tank can be transferred to another tank by recirculating tank contents through the system, using the gas compressors for motive force. The decay tanks are provided with drains to remove condensate that may accumulate, and pressure relief valves to prevent overpressure.

Two sets of redundant oxygen and hydrogen analysers are provided to ensure that oxygen concentrations setpoints are not exceeded. The gas analysers are continuously running during

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[2] [REDACTED]

normal operation, automatically cycling the input between the waste storage tanks. During planned releases, the inlet for the gas analyser will be aligned to sample the gas during its release.

The gas is ultimately discharged to the RAB exhaust through a monitored release path. Gases from the decay tanks can also be routed to be used as cover gases to the effluent tanks or volume control tanks.

##### 13.2.3.4.2 Pressure Control

When liquid is diverted to an effluent holdup tank, the waste gas compressor aligned to the vent/cover gas header will start (or load) on rising header pressure and discharge to the GDT aligned to receive gas.

When liquid is withdrawn from a CVC effluent holdup tank, the aligned GDT maintains vent/cover gas header pressure by providing deoxygenated cover gas through a regulator and maintains a slightly positive pressure in the header to prevent oxygen intrusion.

When the GDT aligned for cover gas duty is depleted, another GDT is selected. If no GDTs are available to provide cover gas, the cover gas header is automatically supplied from the plant nitrogen header.

##### 13.2.3.4.3 Hydrogen Control

Where the potential for an explosive mixture of hydrogen and oxygen exists, the GRW is designed to maintain system integrity. Parallel gas analysers are used to detect the formation or buildup of explosive mixtures, and the analysers annunciate both locally and in the main control room for remedial action.

The GRW shall be continuously maintained non-flammable, by maintaining an oxygen free (< 4% by volume) atmosphere. Additionally, the gas in the GRW will be maintained slightly above atmospheric pressure and the ventilation system will provide continuous ventilation air to remove potentially flammable leakage from spaces containing GRW equipment. Sample bottles and associated equipment will be designed to be evacuated or inerted prior to drawing a sample.

##### 13.2.3.4.4 Abnormal Operation

The response of the GRW to foreseen abnormal operating conditions can be found below:

- If high oxygen levels are detected in the system, the inlet valve to the GRW is closed and a full nitrogen purge of the system is conducted. Manual restart of GRW processing is required once oxygen levels return to normal range.
- If radioactivity levels are exceeded in the outlet line from the GRW, the actuated valve automatically closes to prevent further discharge and nitrogen is injected in the discharge line to dilute the gas and provide circulation force. Manual restart of GRW discharge is required once activity levels return to normal range.

#### 13.2.3.5 System Reliability Features

The GRW is designed with two redundant compressor systems, multiple GDTs, and the ability to transfer from one tank to another. The gas analysers are redundant. The gaseous release trip valve fails shut on loss of power or loss of signal to prevent an uncontrolled release of radioactive gas. Piping and components use welded fabrication to the greatest extent practical to minimise potential leak locations. Specified pumps and valves are designed with a proven history of satisfactory performance in similar systems at existing plants. Stainless steel is used in components in contact with the waste gas environment to prevent corrosion.

#### 13.2.3.6 Inspection and Testing

The equipment arrangement is designed to permit periodic inspection and testing. Sufficient space will be provided for personnel, inspection equipment, remote inspection equipment, removal space and temporary storage, handling machinery, and repairs/replacement.

Testing provisions will be incorporated into the system design to enable periodic re-evaluation of the functionality and performance of all active components in the systems. Programs will be developed for in-service inspection and testing activities during detailed design in accordance with American National Standards Institute (ANSI) / American Nuclear Society (ANS) - 55.4 [32] and Regulatory Guide 1.143 [33].

#### 13.2.3.7 Combination of RWB and RAB on GRW

A design decision paper [29] has been produced to outline the impacts of the absorption of the RWB functions into the RAB. These are summarised below for the GRW:

- The avoidance of additional dedicated HVAC equipment and infrastructure for the RWB, such as the interconnection from the RWB to the plant vent. This reduces the infrastructure footprint and cost.
- Fewer gaseous effluent transfer routes reduces operational radiation exposure.
- A reduction in the number of potential release paths to the environment due to a simplified ventilation system.

### 13.2.4 Solid Radioactive Waste System

#### 13.2.4.1 System Overview

The SRW collects, processes, packages, and stores radioactive solid wastes generated from normal plant operations, including AOOs. These wastes include spent resins, filter bed media, filter cartridges, HVAC filters, tools, Personal Protective Equipment (PPE), and other potentially contaminated wastes. The SRW consists of three major waste streams:

- Wet Solid Wastes (WSW).
- Dry Solid Wastes (DSW).
- Miscellaneous Wastes.

The SRW contains two spent resin tanks that collect, and store contaminated spent resin prior to processing by mobile equipment. All other waste streams are collected and stored in the RAB prior to interim storage or offsite disposal through approved disposal routes. Additional information on the design can be found within the SDD for SRW [34] and the SRW P&ID for spent resin operations [35].

### 13.2.4.2 System Boundaries

Table 3 below presents the key systems that interface with the SRW [34].

**Table 3: Summary of SRW Interfaces**

| System | | Function |
|---|---|---|
| CAI | Compressed and Instrument Air System | The CAI provides service air to the spent resin tanks to aid in mixing and fluidizing the resin bed. The CAI also provides an air supply to control valves with diaphragm actuators. |
| CVC | Chemical and Volume Control System | Spent resin and filter cartridges from the CVC are sent to the SRW for storage, processing, and disposal. |
| DWS | Demineralized Water Transfer System | The DWS provides water for flushing pipelines following resin transfers. |
| LRW | Liquid Radwaste System | Liquids removed from processing solid wastes are sent to the LRW for storage and treatment. Spent resin and filter cartridges from the LRW are sent to the SRW for storage, processing, and disposal. |
| MFS | Main Feedwater System | Spent resin from the condensate polisher package in the MFS may be sent to the SRW for storage, processing, and disposal if the resins become radioactively contaminated. |
| PSL | Primary Sampling System | The PSL samples the spent resin tanks for radioactivity. |
| RBV | Radioactive Waste Building HVAC System | Mobile equipment for processing SRW is vented to the RBV. |
| RCV | Radiologically Controlled Area HVAC | The spent resin tanks are vented to the RCV. |
| RDS | Radioactive Drain System | The RDS collects liquid wastes from SRW equipment drains, as well as spills from processing performed by the SRW and transports them to the appropriate LRW subsystem for processing. |
| SFC | Spent Fuel Pool Cooling System | Spent resin and filter cartridges from the SFC are sent to the SRW for storage, processing, and disposal. |

### 13.2.4.3 System Description

The SRW is responsible for collecting several categories of solid waste. These are WSW, DSW, and miscellaneous solid waste. All solid wastes will be packaged in suitable containers appropriate for their classification, ensuring safe storage and compliant transport to off-site disposal facilities. The SRW consists of two spent resin tanks, two resin pumps, a filter transfer cask, and connections for mobile processing equipment. The SRW system is common to Units 1 and 2, and all waste will be processed through the equipment presented.

The SRW system is designed to be available to receive wastes at all times and during all phases of station operation. It has adequate capacity to handle waste resulting from all operating modes, shutdown modes, and AOOs [30].

I&C are provided to allow operation of the system from control panels. The system is designed for processing upon manual initiation. Manual stop or override is provided for all automatic processes. Instruments are selected for proper function and reduced maintenance. Measurement elements, like tank and waste container level detectors, are non-contact devices.

#### 13.2.4.3.1 Wet Solid Waste

WSW arisings consist of spent resin, filter bed media, and filter cartridges from radioactively contaminated systems. The treatment of WSW has been separated into two different processes for the purposes of the generic SMR-300 design: spent resin handling and filter cartridge processing. Materials are selected to meet the corrosion and environmental conditions anticipated for the specific equipment of the WSW for both normal and off-standard conditions.

##### 13.2.4.3.1.1 Spent Resin Handling

The spent resin handling system receives spent resin from the CVC, SFC and the LRW. The system also receives filter bed media from the LRW. All equipment associated with the spent resin handling subsystem is located within the RAB. The spent resin handling subsystem comprises the following equipment:

- Spent Resin Tanks.
- Transfer Pump.
- Resin Mixing Pump.
- Resin Fines Filter.
- Sampling Unit.

High radiation level resins typically originate from the CVC demineralisers. Lower radiation level resins typically originate from the LRW demineralisers. Both spent resin tanks are identical and interconnected, allowing them to operate as parallel tanks as needed. The tank that receives the initial high activity resin will remain as the allocated high activity resin tank through operation to prevent possible cross-contamination of lower activity resins.

The spent resins are transferred from the spent resin tank to the desired packaging container, which is yet to be confirmed, using the resin pump. Provision for mixing and recirculation of the spent resin tank contents will be present. Further definition of this will be provided as the design progresses. The spent resin will be conditioned prior to packaging and storage on-site.

Hydrogen monitors are provided to monitor the atmosphere in the spent resin tanks to ensure that if any explosive gases are present, they will be vented to the RCV.

Monitoring capabilities such as pressure, flow, level, and radiation are provided during the resin transfers and dewatering operations.

#### 13.2.4.3.2 Dry Solid Waste

DSW consist of HVAC filters, including HEPA filters, PPE and any other dry components that are potentially contaminated. DSW will be sorted, segregated and processed within the RAB. Presently, the specific location to be assigned for these operations within the RAB are under development. A design challenge has been raised to ensure that sufficient space is available for the handling of LLW within the RAB [36].

#### 13.2.4.3.3 Miscellaneous Waste

Miscellaneous wastes are liquid or solid wastes not considered WSW or DSW. These consist of contaminated oily wastes, and mixed wastes which are usually generated from maintenance or decontamination of equipment, and chemical wastes. Chemical waste is collected in the chemical waste tank in the LRW and sent to the SRW for processing via mobile equipment. Contaminated oily wastes and mixed wastes are directly packaged and stored.

#### 13.2.4.3.4 Estimated Solid Radioactive Waste Volumes

The estimated volumes of solid radioactive waste arisings as well as their respective UK waste classifications are found in the Calculation of SMR-300 Solid Radiological Waste (SRW) Inventories [37] report.

#### 13.2.4.3.5 Solid Waste Packaging

The design of the SMR-300 has been undertaken using the United States (US) guidelines and legislation as its basis. For that reason, the packaging solutions proposed are subject to assessment to UK context for packaging options and disposal routes. Additional information on solid waste disposability can be found within the Holtec SMR-300 GDA Requesting Party Response to the NWS Expert View on Disposability [38]. The storage, transportation and disposal solutions employed for the solid Low Level Waste (LLW) and Intermediate Level Waste (ILW) arisings shall comply with UK legislative requirements and will adequately consider Relevant Good Practice (RGP) and guidance. Examples include the Logistics Services Brochure [39] and the Waste Package Specification and Guidance Documentation [40] prepared by Nuclear Waste Services (NWS).

### 13.2.4.4 System Operation

The SRW is required to operate during all normal operating conditions, including refuelling and maintenance outages. SRW equipment and components that perform non-safety functions are monitored and controlled by the PCS. SRW instrumentation provides signal to the PCS directly. As the SRW does not perform a safety function on plant, there is no interaction with the PSS.

A summary of the operations associated with normal operation and AOOs of the SRW can be found below.

#### 13.2.4.4.1 Normal Operation

##### 13.2.4.4.1.1 Spent Resin Processing Operations

Once the resin has been sufficiently exhausted such that it requires processing it is transferred to the spent resin tanks using demineralised water from the DWS. To provide additional shielding and prevent the resin from drying out in the bottom of the tanks, the water level will be maintained above the resin level. The resin mixing pump is used to remove excess water in the spent resin tank. The resin fines filter prevents resin from entering the pump during dewatering.

When processing is desired, the resin mixing pump is used to fluidise the resin bed by drawing water through the resin fines filter and returning the water to the spent resin tank via eductors. Service air connections from the CAI are provided to the spent resin tanks to aid in fluidising the resin bed and mixing the tank contents as required. Air is vented to the RCV through HEPA filters, to avoid high airborne radioactivity. The resin transfer pump is used to recirculate the resin in the spent resin tanks and to transfer spent resins between tanks. The resin transfer pump is also used to transfer spent resins to the mobile processing equipment. The resin slurry is analysed via the PSL to determine processing and packaging requirements.

The system is then realigned, and the resin transfer pump is used to transfer the resin slurry to the chosen packaging container. When the spent resin transfers are complete, the resin transfer lines are flushed using water supplied by the resin mixing pump. Other filter bed media, such as activated carbon, can be transferred to an empty spent resin tank or transferred directly to a storage container.

Where dewatering is used as the conditioning technique, free liquids shall not exceed 1% of the waste volume a non-corrosive liquid in the container. The container shall not contain any materials prohibited by UK regulations or by the management of the disposal site, such as pyrophoric, explosive, toxic, or infectious materials. Void space within the waste and between the waste and the container is kept to a minimum. If desired, the spent resin tank can be bypassed, and the spent resins can be transferred from the originating system directly to the selected container for conditioning operations.

#### 13.2.4.4.1.2 Spent Filter Processing Operations

Filter condition is monitored by differential pressure or as otherwise recommended by the manufacturer. A shielded filter transfer cask is used to change out high-activity filter cartridges. The filter vessel is drained, the shield plug is removed, and the filter cover is opened. The bottom cover of the filter transfer cask is removed, and the filter transfer cask is placed over the filter vessel. The filter cartridge is lifted into the filter transfer cask using a grapple, and the filter transfer cask is placed on the bottom cover. The filter cartridge is then analysed in the RAB via the PSL and temporarily stored. Based on analysis results, the filter cartridge is conditioned and packaged.

#### 13.2.4.4.1.3 Dry Solid Waste Processing Operations

The following operations summarise the processing of DSW arisings:

- DSW arisings are segregated based on contact dose rate.
- Non-radioactive wastes are removed where possible.
- Radioactive items which can be decontaminated for re-use are returned to the appropriate storage location; and those which cannot be re-used are processed as required.
- Any ILW arisings are not to be sorted further, to minimise operator dose, consistent with ALARP considerations; these are processed and stored appropriately.

#### 13.2.4.4.1.4 Miscellaneous Solid Waste Processing

Mixed wastes and radioactive oily wastes are collected in storage containers and stored temporarily in the RAB prior to disposal off-site.

#### 13.2.4.4.2 Startup Operation

There is no anticipated change in the SRW during startup operations.

#### 13.2.4.4.3 Shutdown Operation

There is no anticipated change in the SRW during shutdown operations.

#### 13.2.4.4.4 Refuelling Operation

There is no anticipated change in the SRW during refuelling operations. The SRW is sized to accommodate the increased generation rate of wastes resulting from refuelling operations.

#### 13.2.4.5 Combination of RWB and RAB on SRW

A design decision paper [29] has been produced to outline the impacts of the absorption of the RWB functions into the RAB. These are summarised below for the SRW:

- Elimination of transferring solid waste between two separate buildings.
- Risks associated with cross-contamination of liquid and solid waste unchanged as the associated systems continue to remain separate.
- Spent resin waste transfer and conditioning operations are relocated from the RWB to 0' Elevation of the RAB, utilising the open refuelling area for these functions.

## 13.3 RADIOACTIVE WASTE MANAGEMENT CLAIMS, ARGUMENTS, EVIDENCE

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

The fundamental purpose follows a golden thread throughout the SSEC to CAE via the objectives of the PSR, the PER and the Generic Security Report (GSR) [41]. The overarching SSEC claims and the philosophy for their architecture is presented in PSR Part A Chapter 3 [3].

This chapter links to the overarching claim through Claim 2.2 via Sub-claim 2.2.16. Claim 2.2 is focused on the demonstration that the design of SSCs are developed to meet the relevant safety requirements and appropriate codes and standards.

**Claim 2.2:** The design of the systems and associated processes have been developed taking cognisance of relevant good practice and substantiated to achieve their safety and non-safety functional requirements.

As set out in PSR Part A Chapter 3 [3], Claim 2.2 is further decomposed across several disciplines which are responsible for developing the design of relevant SSCs. This chapter presents the radioactive waste management aspects for the generic SMR-300 and therefore directly supports a claim focused on the overall design of radioactive waste management SSCs, Claim 2.2.16. Arguments have been developed to demonstrate this claim and are outlined in sub-chapter 13.5.

**Claim 2.2.16:** SSCs which support the safe management and storage of radioactive waste are designed to ensure safety functions and measures are delivered and radiation exposure and release of radioactivity are minimised ALARP.

Recognising that radioactive waste management is a cross-cutting topic, this chapter also links to the overarching claims through Claim 2.3, which focusses on the demonstration that the whole lifecycle of the reactor is considered in design and safety assessments.

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

Similar to Claim 2.2, Claim 2.3 is further decomposed. This chapter presents the provisions necessary for management of radioactive waste throughout the lifecycle of the generic SMR-300 and therefore supports Claim 2.3.3.

**Claim 2.3.3:** Radioactive waste will be safely managed throughout the entire reactor lifecycle.

Claim 2.3.3 is again further decomposed to into two level 4 claims to give a holistic view of how both the strategy for managing radioactive waste throughout the SMR-300 lifecycle (Claim 2.3.3.1) and the expectations surrounding the aspects associated with the Nuclear

Liabilities Regulations (Claim 2.3.3.2) contribute towards the overall safe management of radioactive waste for the generic SMR-300.

This chapter presents an overview of the strategy to be employed to manage the radioactive waste arising from the SMR-300 across the entire lifecycle and therefore supports Claim 2.3.3.1. Arguments have been developed to demonstrate this claim and are outlined in sub-chapter 13.6.

**Claim 2.3.3.1:** The overall Radioactive Waste Management strategy provides an appropriate means of safely managing operational activities throughout the lifecycle of the generic SMR-300.

Taking cognisance that this topic area sits within umbrella of the NLR, there are additional specific considerations associated with NLR that require addressing within the SSEC. This chapter presents how these aspects are addressed through the design and operation of the SMR-300 and therefore supports Claim 2.3.3.2. Arguments have been developed to demonstrate this claim and are outlined in sub-chapter 13.6.

**Claim 2.3.3.2:** The NLR expectations for radioactive waste management are addressed in an appropriate manner commensurate with the lifecycle phase.

Table 4 below, shows in which chapter of this PSR these claims are demonstrated to be met.

**Table 4: CAE Chapters**

| Claim No | Claim | Chapter Section |
|---|---|---|
| 2.2.16 | SSCs which support the safe management and storage of radioactive waste are designed to ensure safety functions and measures are delivered and radiation exposure and release of radioactivity are minimised ALARP. | 13.5 Design of Radioactive Waste Management SSCs |
| 2.3.3.1 | The overall radioactive waste management strategy provides an appropriate means of safely managing operational activities throughout the lifecycle of the generic SMR-300. | 13.6 Radioactive Waste Management Lifecycle |
| 2.3.3.2 | The NLR expectations for radioactive waste management are addressed in an appropriate manner commensurate with the lifecycle phase. | 13.6 Radioactive Waste Management Lifecycle |

A summary of the current CAE route map for Part B Chapter 13 is provided in Appendix A.

# 13.4 RADIOACTIVE WASTE MANAGEMENT CODES AND STANDARDS / METHODOLOGIES

This sub-chapter outlines the codes and standards used in the design of SMR-300 radioactive waste management SSCs.

The RP has recognised 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. New codes and standards can be introduced where needed in response to novel design features. Use of such codes will be justified in each case.

## 13.4.1 Codes, Standards and Methodologies used for the Radioactive Waste Management SSCs of the SMR-300

The following US and international codes and standards have been used in the design of SSCs related to radioactive waste management. These include US Nuclear Regulatory Commission (NRC) guidelines identified in areas such as: radioactive waste systems' SDDs, Electric Power Research Institute (EPRI) Utility Requirements Document (URD) [42], ANSI standards and others.

**Table 5: Relevant Codes and Standards to the SMR-300**

| Document | Title | Revision |
|---|---|---|
| United States Nuclear Regulatory Commission, Regulatory Guide 1.26 [43] | Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste Containing Components of Nuclear Power Plants. | Revision 6, December 2021 |
| United States Nuclear Regulatory Commission, Regulatory Guide 1.21 [44] | Measuring, Evaluating, and Reporting Radioactivity in Solid Waste and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants. | Revision 3, September 2021 |
| United States Nuclear Regulatory Commission, Regulatory Guide 1.110 [45] | Cost-Benefit Analysis for Radioactive Waste Systems for Light-Water-Cooled Nuclear Power Reactors. | Revision 1, October 2013 |
| United States Nuclear Regulatory Commission, Regulatory Guide 1.143 [33] | Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants. | Revision 2, November 2001 |
| United States Nuclear Regulatory Commission, Regulatory Guide 4.21 [46] | Minimization of Contamination and Radioactive Waste Generation Life-Cycle Planning. | Revision 0, June 2008 |
| ANSI / ANS-40.37 [47] | Mobile Low-Level Radioactive Waste Processing Systems. | 2009 |
| ANSI/ANS-55.1 [48] | Solid Radioactive Waste Processing System for Light-Water-Cooled Reactor Plants. | 1993 (R2017) |
| ANSI/ANS-55.4 [32] | Gaseous Radioactive Waste Processing System for Light Water Reactor Plants. | 1993 (R2007) |
| ANSI/ANS-55.6 [49] | Liquid Radioactive Waste Processing System for Light Water Reactor Plants. | 1993 (R2007) |
| EPRI, URD Document, Volume III, Chapter 12 [42] | Radioactive Waste Processing Systems. | Revision 8 |

### 13.4.2 UK and International Guidance used in Development of the Generic SMR-300

#### 13.4.2.1 UK Regulatory Expectations

Nuclear safety, civil nuclear security and safeguards, and conventional health and safety at nuclear sites in the UK are regulated by ONR. The regulation of discharges and radioactive waste disposals, and the enforcement of environmental permits of nuclear sites are undertaken by the EA, NRW and the Scottish Environment Protection Agency (SEPA) in England, Wales, and Scotland, respectively.

The focus of the PSR chapters is directed to ONR regulation. The ONR inspectors use Safety Assessment Principles (SAPs) [50] supported by Technical Assessment Guides (TAG) in their regulatory assessment process. Technical Inspection Guides (TIG) are also available to provide guidance in meeting the requirements of site licence conditions. Whilst not aimed for use by the RP, the RP may review these principles and guides to help develop the safety case to satisfy the ONR's regulatory requirements and expectations.

As part of the site-specific licensing process, the prospective licensee must comply with all the nuclear site licence condition (LC). The LCs which are directly applicable to the Radioactive Waste Management Topic area are LC34 – Leakage and escape of radioactive material and radioactive waste and LC32 – Accumulation of radioactive waste [51].

To comply with LC34 the prospective licensee must control radioactive material and radioactive waste on-site. Should any radioactive material leak or escape it shall not do so without being detected by the monitoring systems in place. Additional discussion around the design features implemented within the generic SMR-300 design in order to comply with LC34 can be found in sub-chapter 13.5.

To comply with LC32 the prospective licensee must make and implement adequate arrangements for minimising SFAIRP, the rate of production and total quantity of radioactive waste accumulated on the site at any time and for recording the waste accumulated. Additional discussion around compliance of the generic SMR-300 with LC32 can be found in sub-chapter 13.5 and sub-chapter 13.6.2.5.

In addition to LC34 and LC32, the following LCs are applicable to the Radioactive Waste Management topic area:

- LC4 – Restrictions on nuclear matter on the site.
- LC33 – Disposal of radioactive waste.

### 13.4.2.2 ONR SAPs

ONR SAPs [50] applicable to NLR related aspects of radioactive waste management are set out in Table 6 and described in the relevant PSR Chapters (see interfaces section 13.1.3).

**Table 6: NLR Related SAPs Relevant to Radioactive Waste Management**

| SAP Number | SAP Name | SAP Description |
|---|---|---|
| RW.1 | Strategies for radioactive waste | A strategy should be produced and implemented for the management of radioactive waste on a site. |
| RW.2 | Generation of radioactive waste | The generation of radioactive waste should be prevented or, where this is not reasonably practicable, minimised in terms of quantity and activity. |
| RW.3 | Accumulation of radioactive waste | The total quantity of radioactive waste accumulated on site at any time should be minimised so far as is reasonably practicable. |
| RW.4 | Characterisation and segregation | Radioactive waste should be characterised and segregated to facilitate its subsequent safe and effective management. |
| RW.5 | Storage of radioactive waste and passive safety | Radioactive waste should be stored in accordance with good engineering practice and in a passively safe condition. |
| RW.6 | Passive safety timescales | Radiological hazards should be reduced systematically and progressively. The waste should be processed into a passive safe state as soon as is reasonably practicable. |
| RW.7 | Making and keeping records | Information that might be needed for the current and future safe management of radioactive waste should be recorded and preserved. |
| ECV.1 | Prevention of leakage | Radioactive material should be contained and the generation of radioactive waste through the spread of contamination by leakage should be prevented. |
| ECV.2 | Minimisation of releases | Containment and associated systems should be designed to minimise radioactive releases to the environment in normal operation, fault and accident conditions. |
| ECV.3 | Means of confinement | The primary means of confining radioactive materials should be through the provision of passive sealed containment systems and intrinsic safety features, in preference to the use of active dynamic systems and components. |
| ECV.4 | Provision of further containment barriers | Where the radiological challenge dictates, waste storage vessels, process vessels, piping, ducting and drains (including those that may serve as routes for escape or leakage from containment) and other plant items that act as containment for radioactive material, should be provided with further containment barrier(s) that have sufficient capacity to deal safely with the leakage resulting from any design basis fault. |
| ESR.8 | Monitoring of radioactive material | Instrumentation should be provided to detect the leak or escape of radioactive material from its designated location and then to monitor its location and quantity. |
| ECV.6 | Monitoring Devices | Suitable and sufficient monitoring devices with alarms should be provided to detect and assess changes in the materials and substances held within the containment. |
| ECV.7 | Leakage Monitoring | Appropriate sampling and monitoring systems should be provided outside the containment to detect, locate, quantify and monitor for leakages or escapes of radioactive material from the containment boundaries. |

### 13.4.2.3 EA Environmental Principles

There are several environmental principles which are applicable to radioactive wastes management:

- Radioactive Substances Regulation (RSR): Objectives and Principles [52]
- RSMDPs [53].
- Radioactive Substances Management Engineering Generic Developed Principles (ENDPs) [54].

Table 7 below sets out the RSMDPs relevant to radioactive waste management.

**Table 7: EA RSMDPs Relevant to Radioactive Waste Management**

| RSMDP Number | RSMDP Name | RSMDP Definition |
|---|---|---|
| RSMDP1 | Radioactive substances strategy | A strategy should be produced for the management of all radioactive substances. |
| RSMDP2 | Justification | Radioactive wastes shall not be created unless the practice giving rise to the waste has been justified (in advance for new practices). |
| RSMDP3 | Use of BAT to minimise waste | BAT should be used to ensure that production of radioactive waste is prevented and where that is not practicable minimised with regard to activity and quantity. |
| RSMDP4 | Methodology for identifying BAT | BAT should be identified by a methodology that is timely, transparent, inclusive, based on good quality data, and properly documented. |
| RSMDP5 | Actions having irreversible consequences | Actions with radioactive substances having irreversible consequences should only be undertaken after thorough, detailed, consideration of the potential consequences of those actions and of the other available options. BAT should be used to prevent irreversible consequences from occurring inadvertently. |
| RSMDP6 | Application of BAT | In all matters relating to radioactive substances, BAT means the most effective and advanced stage in the development of activities and their methods of operation. |
| RSMDP7 | BAT to minimise environmental risk and impact | When making decisions about the management of radioactive substances, BAT should be used to ensure that the resulting environmental risk and impact are minimised. |
| RSMDP8 | Segregation of wastes | BAT should be used to prevent the mixing of radioactive substances with other materials, including other radioactive substances, where such mixing might compromise subsequent effective management or increase environmental impacts or risks. |
| RSMDP9 | Characterisation | Radioactive substances should be characterised using BAT so as to facilitate their subsequent management, including waste disposal. |
| RSMDP10 | Storage | Radioactive substances should be stored using BAT so that their environmental risk and environmental impact are minimised and that subsequent management, including disposal is facilitated. |
| RSMDP11 | Storage in a passively safe state | Where radioactive substances are currently not stored in a passively safe state and there are worthwhile environmental or safety benefits in doing so then the substances should be processed into a passively safe state. |
| RSMDP12 | Limits and levels on discharges. | Limits and levels should be established on the quantities of radioactivity that can be discharged into the environment where these are necessary to secure proper protection of human health and the environment. |
| RSMDP13 | Monitoring and assessment. | BAT, consistent with relevant guidance and standards, should be used to monitor and assess radioactive substances, disposals of radioactive wastes and the environment into which they are disposed. |
| RSMDP14 | Record keeping | Sufficient records relating to radioactive substances and associated facilities should be made and managed so as: to facilitate the subsequent management of those substances and facilities; to demonstrate whether compliance with requirements and standards has been achieved; and to provide information and continuing assurance about the environmental impact and risks of the operations undertaken, including waste disposal. |
| RSMDP15 | Requirements and conditions for disposal of wastes | Requirements and conditions that properly protect people and the environment should be set out and imposed for disposal of radioactive waste. Disposal of radioactive waste should comply with imposed requirements and conditions. |

#### 13.4.2.4 Relevant ONR Technical Assessment Guides

ONR TAGs relevant to radioactive waste management are listed below:

- Regulating duties to reduce risks to ALARP [55].
- Management of Radioactive Material and Radioactive Waste on Nuclear Licensed Sites [56].
- Redundancy, Diversity, Segregation and Layout of Structures, Systems and Components [57].
- Categorisation of Safety Functions and Classification of Structures and Components (SSCs) [58].

#### 13.4.2.5 Relevant National and International Guidelines

A non-exhaustive list of relevant national and international guidance applicable to the radioactive waste management aspects of the SMR-300 design is list below. The following is considered to represent best practice in the UK with International Atomic Energy Agency (IAEA) and Western European Nuclear Regulators Association (WENRA) guidance specifically referenced throughout the ONR TAGs:

- International Atomic Energy Agency (IAEA) safety standards:
  - IAEA Fundamental Safety Principles: Safety Fundamentals [59].
  - General Safety Requirements Part 5: Predisposal Management of Radioactive Waste [60].
  - Specific Safety Guide No.40 Predisposal Management of Radioactive Waste from Nuclear Power Plants and Research Reactors [61].
  - Storage of Radioactive Waste, Safety Guide 2006 [62].
- WENRA guidance:
  - Safety Reference Levels for Existing Reactors [63].
  - Reactor Harmonisation Working Group Report on Safety of New NPP Designs [64].
  - WENRA Report on Treatment and Conditioning Safety Reference Levels [65].
  - Decommissioning Safety Reference Levels [66].
  - Waste and Spent Fuel Storage Safety Reference Levels [67].
- Department of Energy & Climate Change (DECC):
  - UK Strategy for the Management of Solid Low Level Waste from the Nuclear Industry [68].
- Department for Energy Security & Net Zero (DESNZ):
  - UK Policy Framework for Managing Radioactive Substance and Nuclear Decommissioning [69].

The suitability of the codes and standards used for the design, analysis and substantiation of mechanical SSCs are outlined PSR Part B Chapter 19 [20].

# 13.5 DESIGN OF RADIOACTIVE WASTE MANAGEMENT SSCS

This sub-chapter outlines the design methodologies used in the design of SMR-300 radioactive waste management SSCs. It breaks down these methodologies into three arguments to cover the relevant aspects associated with the design of the generic SMR-300 which ensure that safety functions are delivered, and radiation exposure and release of radioactive material are minimised ALARP. The arguments are presented below and the corresponding evidence for each of these arguments can be found in their respective sub-chapters:

- **Argument 2.2.16-A1:** Sub-chapter 13.5.1 provides an overview of the codes and standards used for the design of the radioactive waste SSCs and how these codes and standards contribute towards the minimisation of generation of radioactive waste.
- **Argument 2.2.16-A2:** Sub-chapter 13.5.2 provides an overview of the methodology used to identify the faults associated with the operation of the radioactive waste management SSCs.
- **Argument 2.2.16-A3:** Sub-chapter 13.5.3 provides an overview of the EIMT strategy for the radioactive waste management SSCs.

The arguments, and subsequent evidence, outlined within the following sub-chapters has been presented to provide confidence that Claim 2.2.16 has been demonstrated to a maturity appropriate for this revision of the PSR.

## 13.5.1 Design Codes and Standards

**Argument 2.2.16-A1:** Radwaste SSCs are designed and operated to relevant codes and standards so as to avoid and minimise SFAIRP the generation of radioactive waste.

### 13.5.1.1 Evidence for Argument 2.2.16-A1

As discussed within sub-chapter 13.4, the codes and standards used for the design of the generic SMR-300 comprise of guidance from US NRC regulatory guides as well as internationally recognised ANSI/ANS standards and design requirements stemming from the EPRI URD [42].

The SDDs for each of the radioactive waste management systems [25] [30] [34] outline the codes and standards used for the respective design of the systems. The regulatory compliance reports for each of these systems [70] [71] [72] describes how the design of each of the radioactive waste management systems aims to be compliant with the US regulatory requirements.

The following subchapters identify documentation to provide evidence that the US standards used for the design of the generic SMR-300 represent UK best practice. Within the system requirements reports [73] [74] [75] for each of the systems, the source of the design requirements is laid out and the features within the generic SMR-300 design are detailed to outline how the requirement has been sufficiently met by the design. As the requirements all stem from either the EPRI URD [42] or the respective ANSI/ANS standards, the design has been undertaken in accordance with internationally recognised guidance and standards. As such, it is claimed that these standards will contribute to the demonstration of good practice for an operating plant in the UK.

At Step 2 this claim has been substantiated through:

- An assessment of the PSR revision 1 claims and arguments within the sub-chapters above and their alignment with the radioactive waste management SAPs.
- A generic SMR-300 safety principles alignment review against the SAPs for all topic areas within the scope of GDA.
- Consideration of the UK specific waste management requirements during the development of the decision paper and design specification of the RAB.

#### 13.5.1.1.1 Regulatory Alignment

Due to the overlap between the NLR expectations and the ONR SAPs, alignment with many of the radioactive waste management SAPs is inherently discussed throughout this PSR chapter. This alignment is summarised in Table 8, which maps SAPs to relevant sub-chapters within this report.

**Table 8: SAP Demonstration in PSR Part B Chapter 13**

| SAP Number | SAP Name | Sub-chapter(s) Discussed |
|---|---|---|
| RW.1 | Strategies for radioactive waste | Sub-chapter 13.6.1 |
| RW.2 | Generation of radioactive waste | Sub-chapter 13.6.2.2 |
| RW.3 | Accumulation of radioactive waste | Sub-chapter 13.6.2.5 |
| RW.4 | Characterisation and segregation | Sub-chapter 13.6.2.3 |
| RW.5 | Storage of radioactive waste and passive safety | Sub-chapter 13.6.2.4, Sub-chapter 13.6.2.6 |
| RW.6 | Passive safety timescales | Sub-chapter 13.6.1 |
| RW.7 | Making and keeping records | Sub-chapter 13.6.2.8* |

* Demonstration of meeting record keeping requirements is not fundamental at a 2-Step GDA; however, future liability management plans are discussed.

The substantiation of the claims and arguments presented within the sub-chapters above collectively support for a demonstration of alignment with the radioactive waste management SAPs.

Additionally, a regulatory alignment review has been undertaken throughout Step 2 of the GDA to provide up-to-date alignment statements for the generic SMR-300. This includes a review against the radioactive waste management ONR SAPs, which is presented in Appendix C. The alignment review further demonstrate the UK regulatory alignment of the SMR-300.

An alignment review was performed for the radioactive waste management topic and not for other PSR chapters due to the UK specific regulatory context that governs radioactive waste management.

#### 13.5.1.1.2 SSCs Regulatory Alignment Review

Within Appendix C, examples are drawn from the relevant SDDs, EPRI guidance and ANSI/ANS standards as to how design principles have been implemented within the design of the generic SMR-300 to prevent, and where that is not possible, minimise, the generation of radioactive waste.

Appendix B of this PSR chapter outlines additional design features implemented to minimise the generation of radioactive waste, with examples drawn from internationally recognised codes and standards that align with the SAPs relating to containment, confinement, and monitoring and sampling. This aids in the demonstration that the design of the generic SMR-300 is not only aligned with the radioactive waste management SAP concerning minimisation of waste but more holistically those SAPs which aid in the reduction of radiation exposure and release of radioactivity as outlined in Claim 2.2.16.

#### 13.5.1.1.3 Decision paper and Design Specification of the Reactor Auxiliary building

Both the decision paper [29] on the merging of the RWB into the RAB and the design specification for the RAB [76] contains design features intended to facilitate the minimisation of radioactive waste. These are summarised for each of the radwaste processing systems within sub-chapters 13.2.2.5, 13.2.3.7 and 13.2.4.5 for the LRW, GRW and SRW respectively.

## 13.5.2 Safety Assessment

**Argument 2.2.16-A2:** SSCs which support the safe management and storage of radioactive waste ensure faults and hazards arising from failures of the SSCs are minimised. Safety functional requirements are identified for radwaste systems and facilities and are adequately satisfied by the SSCs in the generic SMR-300 design.

### 13.5.2.1 Evidence for Argument 2.2.16-A2

#### 13.5.2.1.1 SMR Class

To ensure compliance with NRC Regulatory Guide 1.26 [43], SMR-300 SSCs are assigned an SMR class. The SMR classification ensures alignment between the safety importance of engineered systems and the associated quality requirements for the design, analysis, manufacture, test, inspection and certification. The classifications range in importance from Class A to Class F and are discussed further in PSR Part A Chapter 2 [7].

Radioactive waste management systems are assigned an SMR Class D as they may accumulate radioactive material during the course of normal operations and are therefore subject to augmented requirements on procurement, inspection, or monitoring [77]. The radioactive waste management systems are also required to meet Regulatory Guide 1.143 which requires that SSCs are designated a specific safety classification based upon their safety importance, these are: RW-IIa (High Hazard), RW-IIb (Hazardous), and RW-IIc (non-safety). At this time, the safety classification in accordance with Regulatory Guide 1.143 has not been established for SMR-300 SSCs. The designation of the safety classification will inform the detailed design of the radioactive waste management SSCs and will be assessed within future safety submissions beyond the PSR.

The comparison between the US classification systems and UK Category and Classification system is discussed in sub-chapter 13.5.2.1.4.

#### 13.5.2.1.2 Hazard Identification

A HAZOP 1 [18] has been performed for the radioactive waste management SSCs and operations The purpose of a HAZOP is to carry out a systematic review of activity nodes with a multidisciplinary group using specific keywords to identify hazards associated with the design and associated activities. The following scope was covered in the HAZOP:

- Liquid radioactive waste (collection) – covering collection and storage of liquid radioactive waste arisings from the SMR-300 prior to them being treated.
- Liquid radioactive waste (treatment) – covering both the pre and post filters, the deep bed filter and the ion exchange columns.
- Liquid radioactive waste (monitoring) – covering the post treatment monitoring of the LRW waste, prior to environmental discharge.
- Gaseous radioactive waste – covering the entire GRW.
- Solid radioactive waste (spent resin) – covering all operations relating to spent resin transfer and handling.
- Solid radioactive waste (filter cartridge processing operations) – covering activities associated with filter cartridge replacement and retrieval including handling operations for the filter cartridges from being retrieved to ultimately being stored for monitoring prior to conditioning, packaging and disposal.

The output of the HAZOP [18] has been sentenced into the Consolidated Fault Listing (CFL) within the Preliminary Fault Schedule (PFS) [78]. Further hazard identification studies including a complete Fault Schedule for Radioactive Waste Management will be performed following design development post-GDA.

#### 13.5.2.1.3 Key Hazards and Safety Measures

The following is a summary of the key hazards and safety measures identified in the HAZOP [18]:

##### 13.5.2.1.3.1 Solid Radioactive Waste

The key hazards associated with the processing of spent resin involve the loss of resin containment due to equipment failure and a release into the surrounding areas. The risk associated with these hazards are minimised through robust design of tanks, piping, and equipment, incorporation of bunding to limit material migration, and use of remote operation panels and administrative access controls to reduce operator exposure. Hydrogen-related fire and deflagration hazards are mitigated via ullage monitoring, ventilation connections, and coolant degassing prior to storage.

For spent filter cartridges, handling risks are minimised using a purpose-designed, remotely operated transfer cask within a restricted area, with administrative controls in place to minimise operator exposure during replacement and processing activities.

#### 13.5.2.1.3.2 Liquid Radioactive Waste System

The key hazards associated with these systems are loss of containment due to failure of the collection tanks and LRW demineralisers (including associated pipework and equipment) with an operator in proximity. These faults are mitigated through use of appropriately designed equipment with a suitable monitoring and maintenance regime and remote control of equipment via an operator station and control panel.

Hazards associated with hydrogen fire and deflagration are also identified and mitigated through hydrogen monitoring in the tanks, de-gassing operations being conducted upstream of the LRW and venting of the LRW tanks to the RCV as well as hydrogen monitoring in the upstream CVC tanks.

Other more general faults such as degradation, incorrect maintenance and loss of services are identified but their consequences were bounded by the hazards discussed above.

#### 13.5.2.1.3.3 Gaseous Radioactive Waste System

Identified events that result in increased operator dose uptake include erroneous operator entry, loss of confinement and overpressure scenarios. The GRW decay tanks, which are normally pressurised will be protected by overpressure protection measures and administrative controls will prevent erroneous operator entry, reducing risk of operator exposure.

The GRW cover gas normally handles hydrogen gas derived from the reactor coolant. The inert nitrogen cover gas manages the formation of a flammable mixture in the GRW SSCs, combined with continuous monitoring of hydrogen and oxygen concentrations and GRW compressor flow rate.

In the event of containment failure, such as from valve or pressure faults, safety measures include radiation monitoring, a controlled release permit process, and an automatic trip valve to prevent inadvertent discharges.

#### 13.5.2.1.4 Categorisation and Classification of SSCs

The UK safety categorisation and classification methodology associated with the SMR-300 is in the process of being determined, primarily within Part A Chapter 2 General Design Aspects and Site Characteristics [7]. The safety categories and classification of each safety function and SSC will be derived through the application of UK DBAA. This process involves the investigation of each fault sequence by determining the Initiating Event Frequency (IEF) and the unmitigated consequence for each fault sequence. The Safety Assessment Handbook includes the complete approach to conducting DBAA [79].

The process for assigning category and classification beyond Step 2 of the GDA is provided within the Safety Assessment Handbook [79], but informed by the IEF and the unmitigated consequences associated with each fault sequence.

For the faults/hazards identified within the HAZOP [18], the IEFs will be determined on a best-estimate basis. A review of existing safety cases has identified that operator occupancy associated with radioactive waste systems is driven by statutory maintenance such as inspection of pressure systems for Pressure Systems Safety Regulations 2000 (PSSR 2000) compliance which can be found in the Safety Assessment Federation's Guidelines on Periodicity of Examinations for pressure systems [80]. More generally, the failure rates for components can be identified within NUREG/CR-6928 [81].

Specific radiological consequence analysis has not yet been conducted for the radioactive waste systems at this stage. As identified in the HAZOP 1 [18], the processing of resins and filter cartridges will represent the highest dose. Hazards from releases of gaseous waste are not expected to be bounding for operator dose uptake as the inventory nuclides (xenon and krypton) have comparably low dose rates to the nuclides in solid and liquid wastes. The radiological consequences for release of gaseous waste with respect to public dose is addressed within the Holtec SMR-300 Radiological Impact Assessment Topic Report [82].

DBAA has not yet been applied to the radioactive waste management SSCs and therefore the safety function categories and SSC classifications have not yet been derived for the LRW, SRW and GRW systems. This is the subject of a broad Design Challenge which encompasses all generic SMR-300 SSCs [83]. A GDA Commitment is raised in PSR Part B Chapter 14 [16] (**C_FAUL_103**) to progress and complete UK DBAA for the generic SMR-300 which will include all radioactive waste management faults. Should demonstration of equivalency with UK Category and Classification designations result in potential gaps in the current generic SMR-300 design substantiation to meet UK context, these will be managed as Design Challenges via the Design Management Process [84], supported by proportionate ALARP and BAT optioneering studies.

It is established in sub-chapter 13.5 (Argument 2.2.16-A1) that the SSCs are being developed in accordance with good practices for the design of radioactive waste systems, therefore, there is limited risk to future designation of category and classification affecting the design of these systems. Furthermore, as discussed in sub-chapter 13.5.2.1.1, the designation of the radioactive waste in accordance with Regulatory Guide 1.143 will ensure that the design of the SSCs will be developed to a level which is commensurate to the safety importance of the systems. It is concluded that there is confidence that once further safety assessment has been carried out, and safety categories/classifications applied, that the requirements can be accommodated by the design of the radioactive waste management SSCs.

The generation of radioactive waste will be minimised at source through material selection and through the control of coolant water chemistry and is discussed further in Section 13.6.2.2.

#### 13.5.2.1.5 Safety Functional Requirements

At this stage Safety Functional Requirements (SFRs) have not been specifically identified for the radioactive waste management SSCs. SFRs will be developed as part of normal design development, in accordance with the process set out in the Safety Assessment Handbook [79].

### 13.5.3 Examination, Inspection, Maintenance and testing

**Argument 2.2.16-A3:** Examination, Inspection, Maintenance and Testing regimes provide confidence in the design and continued operation of the radwaste systems and facilities for their design lifetime.

#### 13.5.3.1 Evidence for Argument 2.2.16-A3

An EIMT schedule for managing the ageing and degradation of the radioactive waste management SSCs is beyond the scope of a 2-Step GDA; however, a suitable EIMT regime will be developed so as to demonstrate through life reliability in accordance with the methodology outlined within PSR Part B Chapter 9 [13]. This argument will be updated with supporting evidence as and when the EIMT and ageing and degradation regime is developed post-GDA for a UK licence application.

High-level EIMT requirements are presented for each of the radioactive waste management SSCs within the SDDs. They state that the equipment arrangement will be defined to permit periodic inspection and testing. Sufficient space will be provided for personnel, inspection equipment, remote inspection equipment, laydown area, handling machinery, and repairs/replacement so as to demonstrate the through-life-reliability of the SSCs. Additional information surrounding spatial requirements can be found within PSR Part B Chapter 17 [19].

The periodicity of EIMT shall be planned around the plant's operational demands for the waste processing systems, such as refuelling outages and waste processing campaigns. In addition, statutory maintenance requirements such as compliance with PSSR 2000 shall be implemented in the EIMT regime. The Safety Assessment Federation's Guidelines on Periodicity of Examinations for pressure systems [80] and the associated Approved Code of Practice (ACoP) [85] can be used as guidelines to determine the periodicity of inspections.

### 13.5.4 CAE Summary

Claim 2.2.16 concerns how the radioactive waste management SSCs have been designed to ensure that any identified safety functions are delivered, and radiation exposure and release of radioactivity are reduced ALARP. To provide a level of substantiation commensurate to this stage of the generic SMR-300's design development, three arguments have been proposed to provide substantiation to this Claim:

- Argument 2.2.16-A1 aims to demonstrate that the codes and standards used for the design of the radioactive waste management SSCs are in keeping with UK RGP.
- Argument 2.2.16-A2 aims to demonstrate that the process for which hazard identification and subsequent assignment of safety function for the radioactive waste management SSCs will be conducted is a rigorous and comprehensive one.
- Argument 2.2.16-A3 aims to demonstrate that the EIMT regime for the radioactive waste management SSCs to provide confidence in the operation of the radioactive waste management systems throughout their design lifetime.

Argument 2.2.16-A1 is responsible for providing confidence that the design of the radioactive waste management SSCs has been conducted in accordance with codes and standards that align with good practice. The evidence for this argument has been collated from several key design sources as well as within the safety principles alignment review and Appendix B of this

PSR Chapter. Through alignment with US regulatory expectations and international good practice and OPEX, the codes and standards used in the design present a robust and comprehensive baseline of requirements for the SSC design such that it is in line with the expectation of the UK regulatory framework.

Argument 2.2.16-A2 presents the safety assessment work carried out to date on the radioactive waste management SSCs. As the design matures, further safety assessment work will be carried out including DBAA at a future stage to identify the SFRs associated with the radioactive waste SSCs. This additional work is within the scope of PSR Part B Chapter 14 [16] and has been captured as a GDA Commitment (**C_FAUL_103**).

While the EIMT regime for the radioactive waste management SSCs have not yet been defined, Argument 2.2.16-A3 provides confidence that the EIMT regime will be developed following the developed methodology to ensure that dose to operators is reduced and that the SSCs can be operated safely throughout their entire design life. The EIMT regime will be defined at the detailed design stage of the generic SMR-300 at which point additional evidence will be provided in order to substantiate Argument 2.2.16-A3. Additional information surrounding the EIMT regime can be found within PSR Part B Chapter 9 [13].

Through substantiation of the three arguments presented under Claim 2.2.16, there is confidence that:

- The radioactive waste management SSCs have been designed to relevant codes and standards for deployment of the SMR-300 within the UK.
- The safety assessment work which has been conducted thus far and will continue to be conducted will ensure that risks are minimised, SFRs will be appropriately assigned and are adequately satisfied by the design.
- A robust and suitable EIMT regime for operation of the radioactive waste management SSCs in the UK can be developed such that the SSCs can be safely operated through their entire design life.

These three arguments present a holistic case to provide confidence that the design of the radioactive waste management SSCs demonstrate measures that minimise radiation exposure and release are minimised ALARP.

# 13.6 RADIOACTIVE WASTE MANAGEMENT LIFECYCLE

**Claim 2.3.3:** Radioactive waste will be safely managed throughout the entire reactor lifecycle.

Claim 2.3.3 concerning the lifecycle management of radioactive waste for the generic SMR-300 has been decomposed into two level four claims. Each of these claims addresses a specific aspect concerning the lifecycle management of radioactive waste for the SMR-300.

The production and maintenance of a radioactive waste management strategy demonstrates how the design of the generic SMR-300 facilitates for the safe management of radioactive waste generated during normal operations and AOOs. The waste management strategy is consistent with UK policy, good practice and modern standards and practises throughout its lifecycle. Claim 2.3.3.1 addresses the production and maintenance of the radioactive waste management strategy and there is confidence that the arguments and evidence presented to substantiate the claim does so to a level of detail commensurate with the design maturity of the generic SMR-300.

Radioactive waste is one aspect of the broader NLR topic. The arguments presented under Claim 2.3.3.2 have been developed to demonstrate that sufficient evidence is provided to support confidence that all NLR aspects related to radioactive waste management have been addressed with the current design maturity of the SMR-300. Other NLR related aspects are covered in PSR Part B Chapter 26 [22] and PSR Part B Chapter 24 [5].

## 13.6.1 Radioactive Waste Management Strategy

**Claim 2.3.3.1:** The overall Radioactive Waste Management strategy provides an appropriate means of safely managing operational activities throughout the lifecycle of the generic SMR-300.

This sub-chapter outlines the overall radioactive waste management strategy for the generic SMR-300. Where there are gaps in compliance with regulatory requirements, these will be addressed and GDA commitments raised. Evidence will be supplied to provide confidence that gaps present at this stage of design maturity do not present a fundamental issue for the eventual licensing of the SMR-300 on a UK site.

This claim has been decomposed into two supporting arguments concerning the alignment of the radioactive waste management strategy with UK requirements and demonstrates that a viable management strategy for ILW can be developed to mitigate risks associated with differences between the US and UK regulatory regimes. The arguments are presented below and the corresponding evidence for each of these arguments can be found in their respective sub-chapters:

- **Argument 2.3.3.1-A1:** Sub-chapter 13.6.1.1 provides an overview of the radioactive waste management strategy for the SMR-300 and provides confidence of its compliance and alignment with the UK regulatory framework.
- **Argument 2.3.3.1-A2:** Sub-chapter 13.6.1.2 provides discussion around the current gap in the ILW management strategy between the UK and US regulatory regimes. Through the evidence presented it aims to demonstrate that an ILW management

strategy can be developed in accordance with the UK regulatory expectations such that no waste arisings form the generic SMR-300 are without a planned waste route.

The arguments, and subsequent evidence, outlined within the following sub-chapters have been presented to provide confidence that Claim 2.3.3.1 has been demonstrated to a maturity appropriate for this revision of the PSR.

### 13.6.1.1 UK Compliant Strategy

**Argument 2.3.3.1-A1:** A compliant radioactive waste management strategy for the generic SMR-300 aligned with UK policy and strategic frameworks has been established.

#### 13.6.1.1.1 Evidence for Argument 2.3.3.1-A1

Establishing a radioactive waste management strategy for the generic SMR-300 that is compliant with UK regulators, policy and strategic frameworks is critical to ensure that the overall strategy for the management of radioactive provides a means of safely managing operational wastes across the entire reactor lifecycle.

##### 13.6.1.1.1.1 Integrated Waste Strategy

The Integrated Waste Strategy (IWS) is a living document which will be updated throughout the entire lifecycle of the SMR-300. At this stage of development, the IWS outlines the general strategy and approach for the management of radioactive wastes. The IWS has been developed taking into account international waste management safety requirements, UK legislation, policies and good practice. The IWS will form the basis of the Decommissioning and Waste Management Plan (DWMP) at a future site-specific licensing phase. Further details on the specific guidance and policy used during formulation of the IWS can be found in the report itself in Section 4 [86].

The IWS aims to demonstrate that expected waste arisings from the operation of the generic SMR-300 can be managed in a safe and sustainable manner, which protects workers, the public and the environment. Key principles such as the waste hierarchy, RSMDP1 and RW.1 have been considered in the development of appropriate management strategies for the different waste streams expected to arise over the lifecycle of the generic SMR-300. At the site-specific stage, detailed BAT and ALARP optioneering will be undertaken.

Within Appendix B of the IWS, the regulatory requirements and radioactive waste management principles (ONR SAPs and EA RSMDPs) were mapped against content within the IWS and SSEC documentation, to ensure the strategies outlined within the IWS and SSEC aligned with the expectations laid out by both regulators. The mapping exercise indicated that all radioactive waste management SAPs have been suitably considered within the IWS, demonstrating it adopts a suitably holistic for this stage of the GDA process.

Finally, the IWS outlines several key forward actions which require closing during the site-specific licensing phase to ensure any gaps are tracked going forward and all identified actions are suitably closed. The following aspects have been identified as gaps within the IWS that will require addressing at the site-specific stage:

- Conduct optioneering studies for radioactive waste management to identify optimised management routes for the different waste arisings.

- Selection and design of the ILW Storage Facility (ISF) will be developed through detailed optioneering, with due consideration of the principles of ALARP and BAT, as well as UK good practice.
- Development and review of the waste inventory for the quantities and types of operational and decommissioning radioactive waste.
- Further engagement with NWS and Letter of Compliance (LoC) submissions to support endorsement of the radioactive waste management strategy through disposability assessment.
- The transport arrangements of radioactive waste transfers to off-site premises.

#### 13.6.1.1.1.2 SMR-300 ILW Management Strategy: Options Assessment

The ILW management options assessment proposes a solution that is fully compliant with the UK regulatory framework as it utilises UK nuclear standard conditioning techniques. This assessment is not a complete ALARP and BAT demonstration, and is limited in detail due to the level of design maturity for the generic SMR-300. The document is intended to demonstrate that fundamentally there are viable options available for the management of ILW that satisfy regulatory requirements and, commensurate with the level of information currently available, that satisfy GDF requirements at this stage of design maturity for Step 2 of the GDA. Additional Information on this assessment can be found below in 13.6.1.2.1.1.

### 13.6.1.2 ILW Management Strategy

**Argument 2.3.3.1-A2:** A management strategy for intermediate level waste can be developed that shall ensure that no wastes shall arise from the generic design that potentially risk becoming site-based legacy waste without an envisioned waste route.

#### 13.6.1.2.1 Evidence for Argument 2.3.3.1-A2

To comply with Step 2 GDA requirements, the RP provided the UK regulators with a fundamental demonstration that an ILW management strategy can, in principle, be developed and implemented on a UK site. The strategy aligns with UK regulatory requirements (including a demonstration that no problematic radioactive wastes will be generated); and does not challenge the Geological Disposal Facility (GDF) concept. A design challenge [36] has been raised for a future site to integrate a storage facility for ILW. Further requirements have been highlighted for the down-selection a waste container and storage method with ALARP and BAT justification at the site-specific stage of development.

#### 13.6.1.2.1.1 SMR-300 ILW Management Strategy: Options Assessment

Due to the unavailability of an approved disposal route for ILW in the UK, the strategy for its management for the SMR-300 is to condition, package and store the waste on-site while an available disposal route is established. This will either be a GDF or Near Surface Disposal (NSD) facility in line with the UK policy framework for managing radioactive substances and nuclear decommissioning [69].

The ILW anticipated to arise from operation of the SMR-300 is summarised within Table 9. [REDACTED]

The assessment includes a pre-screening stage to down-select options, retaining only those viable for implementation. For the purposes of this assessment, a UK compliant option was selected for evaluation, alongside a US option presented as an opportunity for deployment in the UK. Based on OPEX from other nuclear power plants in the UK, the option selected for assessment comprises conditioning the ILW by dewatering and packaging within a Robust Shielded Container (RSC) for storage at an on-site lightly shielded interim store, until availability of the UK GDF. The US based opportunity selected also employs dewatering, and utilises a High Integrity Container (HIC) for waste packaging, with storage in Holtec's proprietary HI-SAFE above ground storage system.

Both options were quantitatively evaluated based on selected criteria primarily from the Nuclear Decommissioning Authority (NDA) value framework [87] with supplementary criteria concerning technical feasibility of the options from the Nuclear Industry Code of Practice [88]. Through assessment of the containers, it was found that there is a viable waste management strategy for the ILW arising from the SMR-300 in the form of the RSCs with a lightly shielded ISF. This option could be deployed for all anticipated operational ILW arisings and is supported by substantial OPEX within the UK. The option of using HICs stored in a HI-SAFE performed well in terms of technical feasibility due to alignment with the existing design of the generic SMR-300.

[REDACTED]

The baseline ILW management option for the generic SMR-300 is conditioning via dewatering and packaging in an unencapsulated form within an RSC, with on-site interim storage in a lightly shielded ISF.

The ILW Management Options Assessment does not constitute BAT or ALARP optioneering, it is a high-level assessment with the aim of providing confidence that a suitable strategy for the management of ILW for the SMR-300. The assessment's findings provide this confidence through demonstration that the ILW arising from the operation of the generic SMR-300 can be conditioned using standard technologies used within the UK for similar wastes and stored in a passively safe state using NWS endorsed containers. A detailed ALARP and BAT optioneering process is required to be undertaken at the site-specific stage to ensure that as the design develops, the strategy selected for the management of ILW across the lifecycle is in line with the expectations of both the ONR and EA. This work has been captured as a GDA Commitment (**C_RWMA_078**) within PER Chapter 1 [2], see sub-chapter 13.7.4 for the full details of the Commitment.

#### 13.6.1.2.1.2 NWS Expert View

The NWS Expert View on the Disposability [89] provides assessment of the suitability of proposals for packaging of wastes and spent fuel arising from the Holtec SMR-300 in anticipation of geological disposal. This assessment considers both of the packaging options presented within the ILW Management: Options Assessment and provides opinion as to the feasibility of these options for deployment within the UK.

The NWS Expert View concludes that the waste arisings from the generic SMR-300 are not significantly different to those which would arise from existing and planned Giga Watt (GW)-scale reactors, giving confidence that a disposability case could be made for the wastes.

[REDACTED]

### 13.6.2 Nuclear Liabilities Regulations Expectations

**Claim 2.3.3.2:** The NLR expectations for radioactive waste management are addressed in an appropriate manner commensurate with the lifecycle phase.

To ensure that all of these expectations are suitably addressed, the arguments for this claim have been developed to explicitly align with the NLR requirements laid out within the ONR GDA guidance document [90]. The arguments are presented below and the corresponding evidence for each of these arguments can be found in their respective sub-chapters. As the NLR expectations are wide ranging, the number of arguments created to support the claim is larger than for the other claims discussed in the PSR:

- **Argument 2.3.3.2-A1:** Sub-chapter 13.6.2.1 gives an overview of the radioactive waste inventory which has been developed for the generic SMR-300.
- **Argument 2.3.3.2-A2:** Sub-chapter 13.6.2.2 gives an overview of how the generation of radioactive waste is minimised for the generic SMR-300.
- **Argument 2.3.3.2-A3:** Sub-chapter 13.6.2.3 gives an overview of the arrangements required for the characterisation, sorting and segregation of radioactive waste from the generic SMR-300.
- **Argument 2.3.3.2-A4:** Sub-chapter 13.6.2.4 gives an overview of the options for the conditioning, packaging and storage of ILW taking cognisance of the fact that this is a known gap in the generic SMR-300 design.
- **Argument 2.3.3.2-A5:** Sub-chapter 13.6.2.5 gives an overview of how the accumulation of radioactive waste is minimised for the generic SMR-300.
- **Argument 2.3.3.2-A6:** Sub-chapter 13.6.2.6 supplies evidence to provide confidence that for the waste arisings form the generic SMR-300 will be both retrievable and inspectable.
- **Argument 2.3.3.2-A7:** Sub-chapter 13.6.2.7 provides and overview of the engagements with NWS surrounding the disposability of the waste arisings from the generic SMR-300 to provide confidence that there will be no problematic wastes present.
- **Argument 2.3.3.2-A8:** Sub-chapter 13.6.2.8 provides discussion on the requirement for a liabilities management plan for radioactive waste and while it has not been developed for this stage of the PSR, gives assurance that it will be developed and managed throughout the lifecycle of the SMR-300.

#### 13.6.2.1 Radioactive Waste Inventory

**Argument 2.3.3.2-A1:** An inventory of radioactive waste is maintained.

##### 13.6.2.1.1 Evidence for Argument 2.3.3.2-A1

Production of a radioactive waste inventory of operational solid waste arisings and decommissioning wastes has been undertaken for the generic SMR-300. Presently, the operational waste estimations have been produced using a conservative basis in order to produce a bounding waste inventory for the generic SMR-300. The decommissioning waste inventory is qualitative and based on OPEX from other reactors.

#### 13.6.2.1.1.1 Operational Waste Inventory

The Calculation of SMR-300 Solid Radiological Waste (SRW) Inventories [37] report estimates the solid radioactive waste generated in the SMR-300 in support of the GDA. The document summarises the solid waste generation across the plant including both LLW and ILW. A summary table for the wastes anticipated to be generated can be found in Table 9 below. It should be noted that the report makes several assumptions used as the baseline for the calculations which require verification as the design progresses.

**Table 9: Summary of Solid Radioactive Waste Arisings from the Generic SMR-300**

| |
|---|
| [REDACTED] |

Additional information surrounding the activity of specific radionuclides present within the waste streams can be found within the Calculation of SMR-300 Solid Radiological Waste (SRW) Inventories [37] report.

As this is a preliminary assessment of the anticipated arisings from the generic SMR-300, the annualised volumes for the wastes appear to be larger per GWe than other full-size light water reactors. This is thought to be primarily due to the conservatism within the model used to predict the volume of waste to produce a bounding case for waste arisings. It is therefore expected that as the design matures and the models become increasingly accurate, the projected waste volumes are expected to align to those from other light water reactors.

The operational waste inventory will be a living document which will detail the inventory of radioactive waste throughout the entire lifecycle of the SMR-300 and provide accountancy for all radioactive waste on-site. Further quantification and categorisation of radioactive waste inventories has been captured as a GDA Commitment (**C_RWMA_078**) in PER Chapter 1 [2].

##### 13.6.2.1.1.2 Decommissioning Waste Inventory

The UK GDA Decommissioning Waste Inventory for the Generic SMR-300 Design [91] has been produced using a quantitative approach based on the OPEX from the decommissioning of other Pressurised Water Reactors (PWR). The report concludes there is no indication that decommissioning of the generic SMR-300 would generate wastes at risk of becoming a site-based legacy waste without a planned waste route within a UK context.

Anticipated volumes of decommissioning waste have not yet been calculated for the generic SMR-300. Post-GDA a quantitative decommissioning waste inventory will be produced for the SMR-300, this work has been captured as a GDA Commitment (**C_DECO_079**) in PSR Part B Chapter 26 [22]. This will allow for further demonstration and confirmation that decommissioning of the SMR-300 will not produce any wastes which risk becoming a site-based legacy waste.

### 13.6.2.2 Minimisation of Generation

| **Argument 2.3.3.2-A2:** The generation of radioactive waste is minimised ALARP. |
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#### 13.6.2.2.1 Evidence for Argument 2.3.3.2-A2

Minimisation of the generation of radioactive waste is critical to ensuring adherence to the waste management hierarchy. As discussed within sub-chapter 13.5.1, the codes and standards used for the design of the radioactive waste management SSCs are internationally recognised. Application of the waste hierarchy is inherent to these codes and standards and therefore, through compliance with the codes and standards, the design of the generic SMR-300 ensures that the generation of radioactive waste is minimised ALARP.

##### 13.6.2.2.1.1 Radioactive Waste SSC Design Documentation

Each of the radioactive waste management SSCs include design features that minimise the generation of radioactive waste. Several examples of these design features are summarised within Appendix B of this PSR chapter. The examples provided within Appendix B provide confidence that minimisation of radioactive waste generation has been embedded within the design of the generic SMR-300 from the outset and aid in demonstrating that this will continue to be prioritised as the design progresses.

##### 13.6.2.2.1.2 Nuclear Island Minimalization Strategy of Activity Generation and Accumulation

The SMR-300 Nuclear Island Minimalization Strategy of Activity Generation and Accumulation [92] provides the strategy used to minimise both the generation and accumulation of activation products in the generic SMR-300 design. The radionuclides which are targeted to be minimised within the primary circuit, alongside the strategy for minimisation of these radionuclides are summarised in Table 10 below:

**Table 10: Summary of Radionuclides to be Minimised in the Generic SMR-300**

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|---|
| [REDACTED] |

Through minimisation of these key radionuclides, dose rates are reduced throughout the plant and the requirements for removal of the activation and corrosion products are minimised. This, in turn reduces the overall radioactive waste arisings. Further strategies employed to reduce the generation of radioactive waste can be found in The Nuclear Island Minimalization Strategy [92].

[REDACTED]

#### 13.6.2.2.1.3 SMR-300 Primary Water Chemistry Strategic Plan

The SMR-300 Primary Water Chemistry Strategic Plan [93] outlines the methodologies used to control the primary water chemistry and the resulting impact this has on the operation of the plant. One of the main objectives of the primary water specification is to reduce the likelihood of Primary Water Stress Corrosion Cracking (PWSCC). Therefore, minimising the corrosion across the plant through control of the primary water chemistry, leads to a reduced requirement for removal of activated corrosion products using the radioactive waste management systems and consequently reduces the overall inventory of solid radioactive waste arisings.

Full details surrounding the methods used for the control of the primary water chemistry can be found within the Primary Water Chemistry Strategic Plan [93].

### 13.6.2.3 Characterisation, Sorting and Segregation

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| **Argument 2.3.3.2-A3:** Radioactive waste is characterised, sorted and segregated to support their future management. |

#### 13.6.2.3.1 Evidence for Argument 2.3.3.2-A3

#### 13.6.2.3.1.1 Characterisation

Wastes will be characterised in line with UK good practice [94] to quantify radionuclide inventory and accurately profile physical and chemical properties (including any hazardous materials) of waste packages, to demonstrate compliance with the management or disposal facility's Waste Acceptance Criteria (WAC).

Characterisation will be used to inform and support sorting and segregation of wastes, in line with the BAT and ALARP assessments, to enable future consignment of wastes to the most appropriate waste routes to ensure optimal management of the wastes. The RP's waste packaging strategies presented in the NWS Expert View Submission [95] maintain flexibility to optimise the consignment of wastes to the most appropriate management/disposal facilities following a period of radioactive decay over the interim storage period.

Waste characterisation records will be generated and maintained by the prospective operator over the lifecycle of the SMR-300 detailing the methodology for determining the wastes inventory, the methodology for determining the radionuclide inventory, including the basis of the derivation of any fingerprints, and details of how these methodologies have been applied.

#### 13.6.2.3.1.2 Sorting and Segregation

Sorting, segregation and characterisation of DSW is to be undertaken within the RAB to optimise subsequent processing and disposal. DSWs are sorted and segregated based on physical and chemical properties depending on the planned treatment route e.g. recyclable waste (such as metal), combustible waste, non-combustible and compactable waste, and non-combustible and non-compactable waste. Pre-treatment, such as cutting, decontamination, drying or dewatering, which is contingent on the requirements of subsequent treatment of each solid waste stream, will be required in the management of DSW. The IWS [86] provides additional detail surrounding the characterisation, sorting and segregation of radioactive waste arisings from the generic SMR-300.

A design challenge [36] has been raised to embed UK-specific requirements for solid LLW handling into the plant layout at the site-specific stage. The challenge covers provisions for laydown areas, sort and segregation by characteristics, on-site treatment and import and export for LLW containers. An assessment will be performed to confirm whether these functions can be accommodated within the RAB or whether a separate, dedicated LLW facility is needed.

[REDACTED] This has been captured as a GDA Commitment (**C_RWMA_078**) within PER Chapter 1 RWMA [2].

With respect to segregation of liquid radioactive waste at source, the RDS provides this function. While the RDS is outside of the scope of this GDA, there is confidence that this system will suitably segregate liquid radioactive waste arisings at source and direct them to the designated storage locations prior to treatment. In addition, high conductivity liquid radioactive wastes are primarily processed via the CVC, with these wastes only being directed to the LRW if they cannot be reused within the primary systems. This segregates high conductivity wastes from the LRW so far is as reasonably practicable and reduces the processing burden on the LRW by performing that function via the CVC.

### 13.6.2.4 ILW Conditioning and Packaging

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| **Argument 2.3.3.2-A4:** Intermediate Level Waste is conditioned and stored in a passively safe state on-site as soon as reasonably practicable. |

#### 13.6.2.4.1 Evidence for Argument 2.3.3.2-A4

As outlined within sub-chapter 13.6.1.2, an ILW Management Strategy Options Assessment [96] was conducted to address the differences in requirements for ILW management between the US and UK. The options assessment presented a UK compliant conditioning, packaging and on-site storage strategy for all operational ILW for the SMR-300 such that the ILW is conditioned and stored in a passively safe state on-site as soon as is reasonably practicable. Full details of the assessment can be found within the assessment report [96]. Compatibility with the existing design of the generic SMR-300 was one of the key criteria used when undertaking the assessment. The baseline conditioning strategy selected for this assessment was dewatering. This conclusion will be reassessed at the site-specific licensing stage.

Dewatering of WSWs is the baseline strategy for the generic SMR-300 and is consistent with the current US design. The US design currently allocates an area for dewatering of HICs within the layout of the RAB [97]. Should RSCs be required for the packaging of the waste there may be a requirement to increase the size of this allocated area due to their larger footprint. This will be covered in the required design change, as outlined in ILW Management Strategy: Options Assessment [96], to review the requirements for the intra-site transit route for ILW across site, from generation to storage post-GDA to comply with UK regulations.

The assessment does not constitute sufficient optioneering to finalise an ILW management strategy and additional BAT and ALARP optioneering will be required at the site-specific licensing stage to establish an optimal solution. Evidence has been provided commensurate to a fundamental assessment of the SMR-300 design such that ILW will be able to be conditioned and stored on-site in a passively safe state as soon as is reasonably practicable.

### 13.6.2.5 Minimisation of Accumulation

| **Argument 2.3.3.2-A5:** The accumulation of radioactive waste is minimised ALARP. |
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#### 13.6.2.5.1 Evidence for Argument 2.3.3.2-A5

The accumulation of radioactive waste in the generic SMR-300 design will be minimised to reduce the safety risk to workers when the appropriate disposal routes are available, which is consistent with the radioactive waste management SAP, RW.3 [50]. However, prior to shipment for off-site disposal, packaged LLW will be stored in a buffer storage area in the RAB for temporary storage. This process will be developed at the site-specific stage, taking into account practicable factors, including the timescale for availability of off-site waste services and the capacity of short-term waste storage needed to enable economic bulk transportation while minimising accumulation.

Where disposal routes are not yet available for the radioactive waste arisings such as ILW, these wastes will be stored on-site until a disposal route, such as a GDF or NSD facility is available to accept the wastes. While the design of the on-site store is not presently included within the design of the SMR-300, this is a recognised gap and one which will be addressed through a design modification during a later stage of the licensing process and is covered as part of GDA Commitment (**C_RWMA_078**).

The approach to the on-site management of radioactive waste for the SMR-300 has been developed to minimise the potential for on-site accumulation and aims to send wastes suitable for disposal off-site as soon as is reasonably practicable. This is in line with RW.3 as well as LC32 and while the evidence to fully satisfy the SAPs is not present at this stage of the design, there is confidence that through application of the aforementioned strategy and adherence to the GDA commitment surrounding on-site storage of ILW, that accumulation of radioactive waste will be minimised so far as is reasonably practicable across the lifecycle of the SMR-300.

### 13.6.2.6 Waste Retrievability and Inspection

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| **Argument 2.3.3.2-A6:** Radioactive waste arisings are retrievable and are capable of being inspected. |

#### 13.6.2.6.1 Evidence for Argument 2.3.3.2-A6

NWS require that appropriate storage arrangements are maintained for waste packages prior to transport to a GDF [98]. As part of the demonstration of the disposability of the generic SMR-300 ILW through the Expert View process, the interim storage of the waste packages have been considered. No areas of concern have been identified in the NWS Expert View [89].

The storage approach for ILW at the generic SMR-300 will be aligned with the Inter-Industry Guidance (IIG) on the Interim Storage of Higher Activity Waste Packages – Integrated Approach [99]. While this is not statutory regulation, it is recognised as industry best practice. The IIG describes guidance in four principle sections: package performance and design; store performance and design; operation of the storage system and provision of assurance of the system over an intergenerational timescale.

In accordance with this guidance, the SMR-300 storage approach will define the monitoring and inspection requirements and ensure that waste packages are retrievable and meet the eventual WAC, of the GDF [99]. Additionally, Holtec will define the key safety functions of the storage system, how these key safety functions will evolve and how this evolution will be monitored and controlled. The key parts of the storage strategy are:

- Identifying the waste package ‘groups’ likely to evolve in similar ways within the ISF.
- Identifying the waste package safety functions over the lifecycle for each identified waste package group.
- Identifying evolutionary processes that may affect the performance of the waste package safety functions and measurable indicators of these processes and calibrating the indicators, where practicable, to provide indicative package performance zones to guide appropriate actions in response to any measured or inferred evolution.
- Identifying the storage system safety functions and how these will evolve and be monitored, this is the performance of any crane, lifting equipment, store structure.

A Storage Implementation Plan will be developed to define how the monitoring, inspection and intervention plan will be implemented for the specific store. Through detailed BAT and ALARP optioneering of the waste management strategy for the generic SMR-300, with inspection capability and retrievability being key considerations, there is confidence that all waste packages will be retrievable and be capable of being inspected in line with the IIG on the Interim Storage of Packaged HAW [99].

#### 13.6.2.7 Disposability

| **Argument 2.3.3.2-A7:** Radioactive waste arisings are disposable. |
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##### 13.6.2.7.1 Evidence for Argument 2.3.3.2-A7

In order to complete Step 2 of the GDA, the regulators expect the RP to have sought advice from NWS on whether any of the radioactive wastes and spent fuel that are anticipated to arise from the operation and decommissioning of the Nuclear Power Plant (NPP) would present a risk to future disposability. This is described in the Preparation of Expert Views to Support Step 2 of the Generic Design Assessment Process, RWPR63-WI11 [100].

[REDACTED]

NWS noted that they assess the suitability of proposals for packaging ILW in anticipation of geological disposal through Disposability Assessment. At GDA Step 2, it is not appropriate to apply a standard Disposability Assessment due to the early stage in design of the proposals. The Expert View [89] on disposability is intended to highlight any inherent, unmitigated risks to disposability arising from a high-level review of the waste streams and future plans for their management. NWS' assessment included consideration of risks associated with wastes that may have radioactivity levels below the boundary for ILW, that is, those that may be classified as LLW.

NWS concluded that in general the nature of the wastes from the generic SMR-300 are not significantly different to those which would arise from existing and planned PWRs with which they are already familiar, giving confidence that a disposability case for these wastes can be made.

[REDACTED]

The RP has provided a response to the risks identified in the Expert View, there are no areas identified of concern for the future demonstration of disposability of wastes from the generic SMR-300 [38].

#### 13.6.2.8 Liability Management Plan

| **Argument 2.3.3.2-A8:** Liability management plans are maintained for radioactive waste arisings. |
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##### 13.6.2.8.1 Evidence for Argument 2.3.3.2-A8

For a site-specific project developing the PCSR, a Funded Decommissioning Programme (FDP) will be prepared for approval by the Secretary of State, to in compliance with the Energy Act. This will require preparation of a DWMP, setting out plans for spent fuel management, radioactive waste management and decommissioning, and a Funding Arrangements Plan.

The DWMP should contain effective mechanisms for ensuring that the cost estimates for the Designated Technical Matters are robust; are kept up to date; and are consistent with the state of knowledge and technology at the time of calculation. Major project risks must be identified, and due account of risk and uncertainty taken.

Alongside the approval of an operator's FDP, the UK Government will expect to enter into a contract with the operator regarding the terms on which the UK Government will take title to and liability for the operator's spent fuel and ILW. Associated contracts and agreements also typically need to be prepared to support the FDP. During the generating phase of the SMR-300, annual and quinquennial review updates will be made to the FDP, in accordance with the Energy Act [101].

The liability management plan for the radioactive waste arisings will be developed in due course as part of standard progression of the SMR-300 through the regulatory process. This argument will be developed further at the PCSR stage.

### 13.6.3 CAE Summary

Claim 2.3.3 concerns the safe management of radioactive wastes throughout the entire lifecycle of the generic SMR-300. To suitably demonstrate that this claim is achieved to a level commensurate with the expectations of a fundamental assessment, two sub-claims (claim 2.3.3. and claim 2.3.3.2) have been developed.

Claim 2.3.3.1 provides demonstration that a strategy for managing operational wastes throughout the reactor lifecycle can be developed for the generic SMR-300. To substantiate claim 2.3.3.1, two arguments are presented. Argument 2.3.3.1-A1 provides evidence to demonstrate that a UK compliant waste management strategy can be developed for the generic SMR-300. The production of the IWS, sets out robust waste management strategies for the generic SMR-300 in line with UK regulatory requirements.

Argument 2.3.3.1-A2 provides evidence to demonstrate that a comprehensive management strategy for operational ILW can be established. While final BAT and ALARP optioneering is required to select the strategies for the management of operational ILW, the ILW Options Assessment and NWS Expert View demonstrate that a conditioning, storage and disposability case can be made for all operational ILW waste arisings from the generic SMR-300 in line with UK regulatory requirements. It is acknowledged that additional work will be required to address certain requirements, particularly in relation to the space arrangements for LLW management in the RAB and the design of interim on-site storage for operational ILW. This has been captured as a GDA Commitment (**C_RWMA_078**) within PER Chapter 1 [2]. This Commitment details the future work required to be undertaken to address the gaps between US and UK regulatory requirements at the site-specific stage.

Claim 2.3.3.2 addresses the extent to which the generic SMR-300 meets NLR specific to radioactive waste management. This claim is supported by eight arguments, each corresponding to a defined NLR aspect. Evidence is presented that demonstrates that each requirement is being addressed appropriately for this stage of design.

Through production of the operational waste inventory for the generic SMR-300, evidence for Argument 2.3.3.2-A1 has been supplied demonstrating that a radioactive waste inventory is maintained for the generic SMR-300. The IWS represents evidence for Argument 2.3.3.2-A2 as it demonstrates application of the waste hierarchy in the waste management routes and design of the generic SMR-300.

Arguments 2.3.3.2-A3 to 2.3.3.2-A8 are partially substantiated, as further evidence will be generated post-GDA. The majority of this work is deemed as normal business to be conducted at the site-specific licensing stage. The sorting, segregation and characterisation of radioactive waste within the RAB will require additional definition and constitutes a design challenge such that it has been formally raised as a GDA Commitment (**C_RWMA_078**). This commitment also covers the additional work required for BAT / ALARP optioneering and subsequent design of the on-site interim storage facility for operational ILW.

In the case of Argument 2.3.3.2-A6, retrievability and inspectability of ILW will depend on future selection of waste containers and store design, both of which are to be developed post-GDA. Early engagement with NWS on disposability options has contributed to the substantiation of Argument 2.3.3.2-A7 to a level commensurate with a 2-Step GDA. The NWS Expert View identified no fundamental issues with making a disposability case for the SMR-300, providing sufficient confidence at this stage of the GDA that a full disposability case for the SMR-300 can be made at the site-specific licensing stage. Argument 2.3.3.2-A8 presently acts as a placeholder to ensure that a liability management plan is developed and maintained across the entire reactor lifecycle. Evidence to support this argument will be supplied during the site-specific licensing phase.

Claims 2.3.3.1 and 2.3.3.2 have been appropriately decomposed and supported by arguments that are substantiated to the extent possible at this design maturity. Where gaps remain, either it is judged that the outstanding evidence will be generated through future evidence as part of ‘normal business’ (see Appendix A), or a GDA Commitment.

The evidence currently available demonstrates that the radioactive waste management strategy will be capable of managing operational wastes throughout the entire lifecycle of the SMR-300 and that all NLR specific aspects have been suitably addressed within this chapter commensurate to the expectations of a 2-Step GDA. Therefore, this provides confidence that radioactive wastes will be safely managed throughout the entire reactor lifecycle, substantiating Claim 2.3.3 at a level consistent with the requirements at Step 2.

## 13.7 CHAPTER SUMMARY AND CONTRIBUTION TO ALARP AND BAT

This sub-chapter provides an overall summary and conclusion of the radioactive waste management chapter and how this chapter contributes to the overall demonstration of ALARP for the generic SMR-300. PSR Part A Chapter 5 [102] sets out the overall approach for demonstration of ALARP and how contributions from individual Chapters are consolidated.

This sub-chapter comprises the following elements:

- Technical Summary;
- ALARP Summary
    - Demonstration of RGP.
    - Evaluation of Risk and Demonstration Against Risk Targets (where applicable).
    - Options Considered to Reduce Risk;
- BAT Considerations
    - Liquid Radwaste System
    - Gaseous Radwaste System
    - Solid Radwaste System
- GDA Commitments and Forward Actions.
- Conclusion.

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

### 13.7.1 Technical Summary

PSR Part B Chapter 13 aims to demonstrate the following level 3 claims to a maturity appropriate for a PSR:

**Claim 2.2.16:** SSCs which support the safe management and storage of radioactive waste are designed to ensure safety functions and measures are delivered and radiation exposure and release of radioactivity are minimised ALARP.

Three arguments have been presented to demonstrate Claim 2.2.16 is substantiated to a maturity appropriate for a PSR. Sub-chapter 13.5 provides the evidence against each of the three arguments.

The first of these arguments establishes a precedence as to how the codes and standards used within the design of the generic SMR-300 are in line with UK regulatory expectations. This is presented via several key deliverables such as the safety principles alignment review, the design documentation for the radioactive waste management SSCs and added discussion within Appendix B of this chapter.

The second argument provides discussion on the completed and planned safety assessments that ensure safety functions are appropriately assigned to the radioactive waste management SSCs and that they can be successfully delivered across the design life of systems. The evidence presented includes the HAZOP [18] conducted on the radioactive waste management SSCs as well as the approach to categorisation and classification using UK DBAA.

The final argument requires further development in conjunction with the post-GDA development of an EIMT regime for radioactive waste management SSCs. Notwithstanding there is confidence that the systems have been designed with EIMT in mind and that industry best practice will be used when defining the EIMT strategy.

Arguments will require further supporting evidence to be developed post-GDA for claim 2.2.16 to be fully substantiated. However, at this stage of the design, there is sufficient evidence provided to give significant confidence that Claim 2.2.16 is demonstrated to a maturity commensurate with a PSR. Compliance of the design of the radioactive waste SSCs with UK expectations will be further demonstrated as the design progresses and evidence of the inclusion of the requirements in the design will be made clear.

Additional work to assign safety functions and demonstrate their performance will be conducted as part of normal business during design development as will production of a robust and compliant EIMT regime. Therefore, it can be said that the SSCs which support the safe management and storage of radioactive waste are designed to ensure safety functions and measures are delivered and radiation exposure and release of radioactivity are minimised ALARP.

| **Claim 2.3.3:** Radioactive waste will be safely managed throughout the entire reactor lifecycle. |
|---|

Claim 2.3.3 is decomposed into two level four claims, Claim 2.3.3.1 and Claim 2.3.3.2. Both of these level four claims contributes towards the overall substantiation of Claim 2.3.3.

Claim 2.3.3.1 concerns the production of a radioactive waste management strategy for the generic SMR-300. Claim 2.3.3.1 is further decomposed into two arguments. Argument 2.3.3.1-A1 provides demonstration that a UK compliant radioactive waste management strategy can be produced for the generic SMR-300. Through production of the IWS and engagement with NWS there is confidence that no problematic wastes will arise over the lifecycle of the generic SMR-300. It is acknowledged as Future Evidence that the radioactive waste management strategy for the SMR-300 will be further developed and maintained in line with UK regulatory requirements.

Argument 2.3.3.1-A2 aims to demonstrate that a UK compliant ILW management strategy can be developed for the generic SMR-300. Through production of the ILW options assessment, this provides confidence that a fully compliant waste conditioning, packaging and on-site intermediate storage solution in keeping with UK expectations can be developed while preventing foreclosure of future options should they become viable at a later date. Additional design work and options assessment is required at the site-specific stage to select the final strategy for the management of operational ILW for the generic SMR-300 as detailed in GDA Commitment **C_RWMA_078**.

Through demonstration that a UK compliant waste management strategy can be developed and that a solution for the management of ILW arisings from operation of the generic SMR-300 can be implemented in line with UK regulatory expectations and OPEX, there are high levels of confidence that the overall radioactive waste management strategy provides an appropriate means of safely managing operational activities throughout the lifecycle of the generic SMR-300.

Claim 2.3.3.2 identifies the relevant NLR requirements laid out by the ONR, the claim also provides demonstration that they are suitably addressed within the SSEC to a level expected for a PSR. Claim 2.3.3.2 is decomposed into eight arguments, each highlighting how a specific NLR requirement has been appropriately met.

Through demonstration that a compliant radioactive waste management strategy can be developed and maintained throughout the entire reactor life cycle and through demonstration that all NLR requirements have been appropriately addressed within this PSR, there is significant confidence that radioactive wastes will be safely managed throughout the entire reactor lifecycle.

### 13.7.2 ALARP Summary

#### 13.7.2.1 Demonstration of RGP

Generic SMR-300 radioactive waste management SSC are designed to comply with US NRC requirements applicable in the US. The design adopts nuclear-specific codes and standards endorsed by the US NRC, stemming from the EPRI URD [42] or internationally recognised ANSI/ANS standards and design requirements.

The link between the generic SMR-300 design standard requirements, internationally recognised codes of practice and UK RGP is demonstrated in Appendix B. Broadly, the principal codes and standards identified within sub-chapter 13.4.1 align with UK regulatory expectations in the nuclear industry (see section 13.4.2).

Where there are differences between US and UK good practice, there have been specific consideration associated with radioactive waste management within a UK context. Gaps between US practice and UK RGP have been identified due to the differences in disposal routes. The US do not have a requirement for extended duration on-site storage of ILW in a passively safe state and instead the US can dispatch these wastes off-site. This discrepancy between the US and UK warranted a design challenge paper to be submitted to identify that the requirements for on-site interim storage of ILW are considered within the design going forward. This has been recognised as GDA Commitment (**C_RWMA_078**) in PER Chapter 1 [2].

#### 13.7.2.2 Evaluation of Risk and Demonstration Against Risk Targets (where applicable):

The numerical targets against which the demonstration of ALARP is considered can be found in PSR Part A Chapter 2 [7]. Whilst no safety functions have currently been identified for the radioactive waste management SSCs, when they are identified through the fault studies to be undertaken, such as UK DBAA, the SSCs will contribute to the demonstration of ALARP by comparison against the risk targets in two ways:

- By fulfilling safety functions for normal operations (e.g., shielding and containment), and thereby contributing to achieving Targets 1 to 3.
- By achieving their safety classification as a duty system or a protection system, where claimed, they will contribute to the achievement of accident risk, Targets 4 to 9.

Risks below the Basic Safety Objectives (BSOs) are considered broadly acceptable and would satisfy ONR. However, if reasonably practicable to do so the duty holder by law must reduce risks further.

The evaluation of the normal operations and accident risks against Targets 1 to 9 is summarised in PSR Part A Chapter 5 [102].

#### 13.7.2.3 Options Considered to Reduce Risk

The process for the assessment of risk reduction options is presented in Holtec SMR-300 Design Management [84] process.

At this time, the evaluation of the normal operations and accident risks against Targets 1-9 has not been provided. This information will be presented in PSR Part B Chapter 10 [14] for normal operations, and PSR Part B Chapters 14 [16], 15 [103], 16 [17] for accident conditions. Within the radioactive waste management topic area there have been design challenges against the US design to further align the design with the expectations associated with the UK regulatory regime and reduce risks.

The principal design challenge on radioactive waste management was Design Challenge – ILW and LLW Facilities [36] paper, which was concerned the available space for LLW processing and the lack of on-site interim store for ILW in the design as well as the required detailed ALARP / BAT optioneering to be undertaken in order to select the final ILW Management Strategy.

The design challenge originated from the gap analysis conducted at revision 0 of this PSR chapter. The gap in question is a difference in waste categorisation regimes and disposal policies between the UK and the US. The UK context requires all ILW arisings to be safely conditioned, packaged and stored on-site prior to transfer to a GDF when available, and LLW to be processed, packaged and dispatched off-site to NWS for disposal. These waste management requirements are UK context-specific and therefore not accounted for in the generic SMR-300 design.

To mitigate the risk associated with the design challenge surrounding the ILW storage facility, the SMR-300 ILW Management Strategy: Options Assessment [96] was produced as a supporting deliverable. This document outlines a baseline envelope for two options for the strategy for ILW management for the generic SMR-300. The first of which is a de-risking option which is used extensively in UK nuclear contexts regarding storage of the waste in RSCs inside a lightly shielded storage facility. The second option provides an opportunity for innovation and benefits from US operating experience which is storage of the waste in a HIC inside a HI-SAFE storage module. The options assessment provides confidence that a UK compliant strategy can be implemented and therefore, as a fundamental assessment for generic design, there are no showstoppers identified and there are sufficient de-risking options available to the RP. For a prospective site application, there are further requirements to down select a waste container and storage method as outlined within GDA Commitment **C_RWMA_078**.

To mitigate the risks associated with the requirements for LLW processing, packaging and disposal, additional investigation is required into the capability of the RAB to house these facilities within its current footprint. Within the UK the following capabilities are typically expected to be present within the LLW handling facilities:

- Laydown areas including buffer storage for the raw waste, the empty waste containers and packaged waste prior to dispatch.
- Sorting and segregation facilities for the wastes based on its characteristics.
- On-site treatment options such as compaction, shredding, bailing etc.
- Import and export areas for the waste containers, including capability to export transport containers such as ISO containers.

The space and layout in the generic SMR-300 design requires further assessment to determine whether there is capacity in the existing RAB arrangements as outlined within GDA Commitment **C_RWMA_078**. This assessment would consider the following options:

- A dedicated facility for on-site handling of LLW.
- Repurposing of existing space and arrangements within the RAB to facilitate LLW handling.

Through the design challenge process, the gaps between UK and US regulatory regimes for ILW and LLW management are being appropriately managed with supporting deliverables being produced to minimise the risks associated with any design changes required. In addition, the GDA Commitment **C_RWMA_078** outlines the required work to be undertaken to successfully demonstrate that the generic SMR-300 design can comply with UK requirements. The gaps which resulted in the design challenges being raised are common to RPs in previous GDAs, as such it is not perceived as a fundamental issue for the generic SMR-300. The provision of GDA commitments in the SSEC will inform a site-specific application, therefore, there is a significant confidence that post-GDA design development of the generic SMR-300 would yield a design which can successfully reduce future risks to ALARP and align completely with the requirements of the UK regulatory framework.

### 13.7.3 BAT Considerations

It should be noted that NLR is a specific technical specialism within the ONR with particular focus on the long timescales over which radioactive waste management and decommissioning can take place; with issues such as potential degradation of facilities, legacy wastes and clean-up. As such, NLR PSR chapters within this GDA have claims which address primarily safety design aspects and regulatory requirements as applied by the ONR. However, due to the cross-cutting aspects of NLR, this chapter also supports environment claims as set out within the PER – particularly related to the prevention/minimisation of radioactive wastes and their related impacts.

All environment claims, applicable to NLR reside within the BAT topic area and will be presented in PER Chapter 6 Demonstration of Best Available Techniques [15]. This chapter is involved in a continuous collaborative process with the BAT topic area and has already provided relevant technical details and information from which the environment claims were constructed. The collective process is further supported by the Holtec SMR GDA PSR Part B Chapter 11 Environmental Protection [104] which provides a ‘golden thread’ between the Safety Case and Environment Case and relevant claims, arguments and evidence found in the PER for PSR chapters. More specifically, environmental protection claims made in the

PER relevant to this PSR chapter include Claim 4.1 Generation of Radioactive Waste; Claim 4.2 Quantity of Radioactive Waste; Claim 4.3 Activity of Radioactive Waste; Claim 4.4 Impacts of Radioactive Waste; and Claim 4.7 Monitoring and Sampling. Substantiation of these claims through developed arguments and supporting evidence will be handled within the Demonstration of Best Available Techniques chapter of the PER and not within this chapter of the PSR. The evidence provided to substantiate the arguments and ultimately the claims from a BAT perspective will be relevant to the radioactive waste management topic area.

#### 13.7.3.1 Liquid Radwaste System

This section provides some early indicative BAT demonstration of the design of the LRW. This shall be built upon through the development and issue of design documentation for the system.

Using the LRW system, liquid wastes produced by the SMR-300 shall be processed, treated and disposed of using BAT, through segregation at source using the RDS and co-collection of wastes in the LRW system. The use of segregation at source ensures that BAT is applied, with each of liquid waste being characterised before processing and the appropriate treatment route being selected for the processing of each waste stream – dependent on its characteristics. This avoids the mixing of different waste streams (e.g. lightly contaminated liquid, heavily contaminated liquid, chemically contaminated liquid) and avoids undesired or premature blinding of resins and filters. This optimises the waste management operations by minimising solid waste arisings.

Characterisation of liquid waste, through sampling and monitoring, also ensures compliance with acceptance criteria for recycling and reuse within the reactor, and with discharge limits.

The use of ion exchange and filtration as the treatment methodology for the LRW adheres to the concentrate and contain principle. This is preferred to the dilute and disperse principle and constitutes the use of BAT, see PER Chapter 6 Demonstration of Best Available Techniques [15].

This process aligns with Environment Agencies' Radioactive Substances Management Developed Principles (RSMDPs) expectations.

#### 13.7.3.2 Gaseous Radwaste System

This section provides some early indicative BAT demonstration of the design of the GRW. This shall be built upon through the development and issue of design documentation for the system.

Gaseous wastes are contained by the GRW system to decay to permitted levels prior to discharge via a monitored release path. The application of BAT within this system can be seen by following the EA's RSMDPs, such as RSMDP12 - limits and levels on discharges, where all decayed gas will be monitored before release to ensure compliance with discharge limits.

Further, the HVAC system which forms part of the GRW system utilises exhaust filters, such as HEPA filters, to trap any particulates preventing their release to the environment. This provides further evidence that BAT has been applied by minimising impact to the environment through entrapment of particulate, which can then be managed via the SRW instead of being released to the environment.

#### 13.7.3.3 Solid Radioactive Waste System

This section provides some early indicative contribution towards BAT demonstration of the design of the SRW. This shall be built upon through the development and issue of design documentation for the system.

As there are multiple sources of solid radioactive waste, the following contributions towards demonstration of BAT are listed:

- Spent resin is stored in tanks, which allows for batch testing. This enables individually tested batches to be routed to the most relevant processing/packaging system and storage location, depending on its characteristics. Further, each batch is then dewatered prior to sealing the package(s), thus minimising the number of packages by optimising the use of space in each package.
- Filters are tested and stored in similar manner to above.
- Contaminated solid wastes are segregated based on contact dose rates to facilitate efficient packaging and for storage prior to processing, which aligns with the requirements of waste management hierarchy. The categorisation of this waste type is not clear at this point in the design whilst the waste inventory is being developed.

### 13.7.4 GDA Commitments

GDA Commitments across the SSEC have been formally captured in accordance with the Commitments, Assumptions, Requirements [8] process. Details on this process are also provided in PSR Part A Chapter 4 [9]. There are no new GDA Commitments identified in this Chapter. However, the GDA Commitment first raised in PER Chapter 1 [2], incorporates key activities and areas for future development that have been identified across this chapter (Arguments 2.3.3.1-A2, 2.3.3.2-A1, 2.3.3.2-A3, 2.3.3.2-A5).

**C_RWMA_078: Information dependent on site-specific factors will be required to meet regulatory expectations in establishing in strategies for ILW and LLW facilities. A Commitment is raised to undertake the following post-GDA activities to ensure site specific application.**

**a) Further quantification and categorisation of radioactive waste inventories.**
**b) Further down-selection of ILW management options, including container type e.g. RSCs or HICs.**
**c) Detailed design development of facilities for ILW storage and LLW handling.**
**d) Optimisation of the use of space allocated to RWM in the RAB or consideration of whether a dedicated facility is BAT.**
**e) Conduct further engagement with NWS for disposability assessment of ILW packages following down-selection of containers and further development of radioactive waste inventories.**

### 13.7.5 Conclusion

The conclusion of this Chapter of the PSR is that:

- There is confidence that the Chapter Claims identified have been met to a maturity aligned with a preliminary safety report. Further evidence will be presented in due course as the design develops, where required.
- Functional requirements have been identified for the radioactive waste management SSCs; however, no safety functions are currently identified through UK DBAA.
- When safety functions are identified, a systematic categorisation and classification system will be applied to the SSCs commensurate with their contribution to nuclear safety as specified within PSR Part A Chapter 2 [7].
- The radioactive waste management SSCs have been designed to US standards which adopt international good practice and broadly align with UK regulatory expectations.
- The substantiation against the identified codes and standards results in a design that contributes to the demonstration that risks to people during normal operations and accident conditions are tolerable and ALARP.
- An IWS has been produced to demonstrate how radioactive waste will be managed throughout the reactor lifecycle, how the operational activities associated with radioactive waste management shall contribute towards the demonstration of BAT and how gaps between US and UK regulation will be addressed.
- An ILW Options Assessment has been produced to mitigate the risks associated with ILW management within the UK and provide a UK compliant solution which is compatible with the design of the SMR-300.
- Engagement with NWS has resulted in their Expert View confirming that the nature of the wastes from the generic SMR-300 are not significantly different to those which would arise from existing and planned PWRs with which they are already familiar, giving confidence that a disposability case for these wastes could be made.
- Undertaking the work laid out in GDA Commitments provides a high level of confidence that future development of the SMR-300 design will further reduce risks to ALARP and demonstrate compliance with all applicable NLR requirements.

PSR Part A Chapter 5 [102] 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.

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## 13.9 LIST OF APPENDICES

# Appendix A PSR Part B Chapter 13 CAE Route Map

A summary of the SSEC CAE route map for radioactive waste management is presented in Table 11.

**Table 11: PSR Part B Chapter 13 CAE Route Map**

| |
|---|
| [REDACTED] |

# Appendix B Radioactive Waste SSC Design Features vs UK RGP Compliance Assessment

The focus of the compliance assessment was to identify within the design of the generic SMR-300, features which contribute towards substantiation of Claim 2.2.16. The focus of the assessment was primarily on the containment and confinement SAPs to address the radiation exposure aspect of the claim, with an additional focus on monitoring and sampling to address the minimisation of releases. Rather than addressing each of the SAPs independently, they were grouped according to those of note within the ONR's assessment plan for the NLR topic areas [105] to ensure all areas of interest were covered, see Table 12 below.

**Table 12: SAP Groupings for UK RGP Compliance Assessment**

| Overarching Grouping | SAP No. | SAP Title | Description |
|---|---|---|---|
| Containment and Confinement | ECV.1 | Prevention of leakage | Radioactive material should be contained and the generation of radioactive waste through the spread of contamination by leakage should be prevented. |
| | ECV.2 | Minimisation of releases | Containment and associated systems should be designed to minimise radioactive releases to the environment in normal operation, fault and accident conditions. |
| | ECV.3 | Means of confinement | The primary means of confining radioactive materials should be through the provision of passive sealed containment systems and intrinsic safety features, in preference to the use of active dynamic systems and components. |
| | ECV.4 | Provision of further containment barriers | Where the radiological challenge dictates, waste storage vessels, process vessels, piping, ducting and drains (including those that may serve as routes for escape or leakage from containment) and other plant items that act as containment for radioactive material, should be provided with further containment barrier(s) that have sufficient capacity to deal safely with the leakage resulting from any design basis fault. |
| Monitoring | ESR.8 | Monitoring of radioactive material | Instrumentation should be provided to detect the leak or escape of radioactive material from its designated location and then to monitor its location and quantity. |
| | ECV.6 | Monitoring Devices | Suitable and sufficient monitoring devices with alarms should be provided to detect and assess changes in the materials and substances held within the containment. |
| | ECV.7 | Leakage Monitoring | Appropriate sampling and monitoring systems should be provided outside the containment to detect, locate, quantify and monitor for leakages or escapes of radioactive material from the containment boundaries. |
| Waste Minimisation | RW.2 | Generation of radioactive waste | The generation of radioactive waste should be prevented or, where this is not reasonably practicable, minimised in terms of quantity and activity. |
| | RW.3 | Accumulation of radioactive waste | The total quantity of radioactive waste accumulated on site at any time should be minimised as far as is reasonably practicable. |
| Characterisation & Segregation | RW.4 | Characterisation and segregation | Radioactive waste should be characterised and segregated to facilitate its subsequent safe and effective management. |

To demonstrate the generic SMR-300 design takes cognisance of UK RGP, the LRW design requirements adopting or echoing internationally recognised codes and standards were identified. Table 13 below presents the links between these codes and standards to UK context and regulatory requirements and expectations.

**Table 13: LRW UK RGP Compliance Assessment**

| Overarching Grouping | LRW | | |
|---|---|---|---|
| | Holtec Requirement | Reference | UK Context Link |
| Containment and Confinement | Berms are required on all tanks that have the potential to contain or are designed to contain radioactive liquids. This will contain leakage in the event of a line or tank failure. | EPRI URD Chapter 12, section 3.4.5.9.4 [42]. | This requirement is based upon EPRI URD which is recognised internationally and within the UK as good practice. |
| | All berms shall have a minimum holding capacity for containment of 110% of the tank volume. | EPRI URD Chapter 12, section 3.4.5.9.5 [42]. | This requirement is based upon EPRI URD which is recognised internationally and within the UK as good practice. |
| | Equipment and piping shall be designed to minimise leaks to comply with 10 Code of Federal Regulations (CFR) 20.1406 and RG 4.21 [106] which mandates the minimization of contamination. This is demonstrated within the design of the SMR-300 via several key design principles taken from EPRI guidance and ANSI/ANS 55.6 | EPRI URD [42], ANSI/ANS 55.6 [49]. | the requirement to minimise leaks and spills and provide containment in areas where such occurrences may occur links directly to ONR SAPS ECV.1, ECV.3 and ECV.4. By not only designing the system such that the chance of leakage in minimised in the first instance but then providing additional containment barriers such as sumps and berms this provides passive measures of confinement. |
| | While the design of the systems is still ongoing, the LRW will be designed to preclude unplanned and/or unmonitored release to the environment. This requirement stems from General Design Criteria (GDC) 60 in 10 CFR 50, Appendix A [107] which states that "The nuclear power unit design shall include means to control suitably the release of radioactive materials in gaseous and liquid effluents". The requirement is echoed in EPRI URD [42]. | EPRI URD Chapter 12, section 3.2.5.1.1.1 [42]. | This generic design requirement concerning the control of releases to the environment is embedded within US legislation. This requirement is also contained within the EPRI URD providing a basis of international good practice for its inclusion within the SMR-300 design. Designing the LRW to preclude unplanned environmental release contributes directly towards the satisfaction of ECV.2 by ensuring that radioactive releases to the environment are minimised. |
| | The LRW will be designed to preclude gravity flow from the systems to environment. This is in line with EPRI requirements and eliminates unplanned or unmonitored releases via gravity or siphon flow. | EPRI URD Chapter 12, section 3.2.5.1.3 [42]. | This is a standard design feature across international designs to eliminate siphoning. |

| Overarching Grouping | LRW | | |
|---|---|---|---|
| | **Holtec Requirement** | **Reference** | **UK Context Link** |
| Monitoring | US NRC 10 CFR 50 Appendix A GDC 64 [107] requires that means shall be provided for monitoring of effluent discharge paths for radioactivity.<br>The principal effluent discharge from the LRW is continuously radiation monitored and can be routinely grab sampled. Continuous monitoring feeds forward to an automatic isolation valve, preventing escape of radioactivity during a non-compliance event. The integration of routine grab sampling with continuous sampling allows for validation of continuous monitoring measurements. This reduces uncertainty in radiation readings and minimises risk of reporting failures.<br>Continuous flow monitoring on discharges is required to estimate quantity of radioactive material discharged. | US NRC 10 CFR 50 Appendix A GDC 64 [107]. | This generic design requirement concerning the control of releases to the environment is embedded within US legislation.<br>Enrolment with the Monitoring Certification Scheme (MCERTS) for quantification of discharge flowrate is a regulatory requirement for UK permitted sites. Flowmeters must be installed, maintained, inspected and operated in line with UK regulatory guidance. The MCERTS flowmeters must be independently inspected by approved parties as part of the scheme. |
| | Compliance with GDC 60 requires that releases of radioactive materials in liquid effluents to the environment are controlled during normal reactor operation and AOOs. GDC 60 specifies that the radwaste processing systems provide for a holdup capacity sufficient to retain radioactive waste, particularly where unfavourable site environmental conditions may impose unusual operational limitations upon the release of effluents.<br>Waste Holdup and Effluent Tanks and associated pumps are sized in accordance with ANSI-ANS-55.6 design inputs (Table 7) | URD Chapter 12, section 3.2.7.1 [42]. | A duty-standby arrangement of waste holdup tanks is provided in line with international EPRI Section 3.2.7.1, enabling one to receive water while the other is being recirculated, sampled and/or emptied.<br>Treated effluent which fails to comply with limits of detection, as is determined through continuous monitoring, is recycled to the waste holdup tanks. If contamination of conventional wastewater occurs, i.e. through steam generator tube leakage, this effluent will be routed to the LRW waste holdup tanks. |
| | Instrumentation and sampling points are provided upstream and downstream of key treatment equipment in the LRW, such as ion exchangers. | EPRI URD Chapter 12, section 3.5.5 [42]. | This approach enables periodic monitoring of equipment performance, allowing corrective actions to be taken before discharges are affected. This is in line with requirements from EPRI URD. |
| | All discharge of liquid radioactive wastes shall be made via tanks wherein the contents of the tank may be mixed and sampled and proven acceptable prior to a batch discharge. All discharge of liquid radioactive wastes to the environment will be held within the monitoring tanks which may be mixed and sampled prior to being proven acceptable for discharge. Each pump includes a recirculation line and will include grab sample provisions. Equipment design details to be further determined during detailed design. | EPRI URD Chapter 12, section 3.2.5.1.2 [42]. | This requirement is based upon EPRI URD which is recognised internationally and within the UK as good practice. |

| Overarching Grouping | LRW Holtec Requirement | Reference | UK Context Link |
|---|---|---|---|
| | Control and monitoring of the release of radioactive materials to the environment shall be consistent with the requirements of the environmental monitoring system of Chapter 9: Site Support Systems. For releases from the GRW, monitoring of the total release at the discharge vent is covered by Chapter 9: Site Support Systems instrumentation.<br>C&I will be considered during detailed design. Required LRW systems instruments and controls including monitoring, alarms and control mechanisms are specified in EPRI Section 3.7.1. | EPRI URD Chapter 12, section 3.5.7 [42]. | This requirement is based upon EPRI URD which is recognised internationally and within the UK as good practice. |
| | Electropolishing of discharge line radiation monitors will be provided to overcome accumulation of contamination on the monitor sensing element. Accumulation of contaminants can produce false readings. Replaceable sleeves or wells may also be used to enhance protection. These features are to be developed at detailed design. | EPRI URD Chapter 12, sections 3.5.18.2 and 3.5.18.3 [42]. | This requirement is based upon EPRI URD which is recognised internationally and within the UK as good practice. |
| | All transfer applications shall include remote technologies related to component contact radiation monitoring, media transfer, video and audio capabilities. The use of remote media handling supports plant staffing optimization and reduces the industrial safety hazards associated with moving heavy loads associated with shielding. Filter housing on primary and auxiliary systems is radiation monitored to facilitate remote changeout. | URD Chapter 12, section 3.4.9.3.1 [42]. | This requirement is based upon EPRI URD which is recognised internationally and within the UK as good practice. |
| | To the maximum practical extent, fixed and mobile radioactive waste processing systems shall be automatically monitored and controlled. Those systems that are batch type systems shall be automatically controlled and shut down after manual initiation by the operator. Manual control and override capability shall be provided, including any instrumentation required for manual control by the operator and alarms to alert the operator that manual override is needed. | URD Chapter 12, section 3.5.1 [42]. | This requirement is based upon EPRI URD which is recognised internationally and within the UK as good practice. |
| | Radioactivity monitoring will be provided for chemical waste arisings which may be contaminated. Alternative flow paths via the high conductivity drainage system will be provided to ensure treatment through the LRW if required, in line with EPRI requirements. | URD Chapter 12 section 3.3.5.3 [42]. | This design feature applies to all streams where radioactivity may foreseeably be detected during all modes of operation. |

| Overarching Grouping | LRW | | |
|---|---|---|---|
| | Holtec Requirement | Reference | UK Context Link |
| Waste Minimisation | US NRC 10 CFR 20.1406 [106] mandates that facility design will minimise, to the extent practicable, the generation of radioactive waste. This is implemented in the SMR-300 design within the LRW through the selective loading and operational flexibility of the Ion Exchange Columns. The Ion Exchange Columns will be selectively loaded with resin depending on the plant conditions and waste needs. The ability to bypass Ion Exchange Columns if the waste streams are clean and do not require processing as well as having selectivity over the ordering of the final two ion exchange columns allows for the resin within the columns to be fully exhausted prior to resin change out. This optimizes the resin utilization, minimising solid waste generation. | This does not have a direct link to a design code and standard. | Despite this feature not having a direct link to a design code and standard, this is an operational decision from Holtec which facilitates the minimisation of generation and promotes operational flexibility. These principles are echoed within the SAPs which specifies under RW.2 [50] that the safety case should highlight specific design provisions and operating practices which aid in the minimisation of generation of radioactive waste in accordance with LC32. |
| | The use of ion exchange columns as opposed to evaporators for liquid radioactive waste processing is a design feature which will minimise the extent of solid waste arisings from the operation of the SMR-300. This is claimed as one of the key design features which contributes towards minimization of solid radioactive waste within the EPRI URD. | EPRI URD Chapter 12, section B.1.2.1 [42]. | This requirement is based upon EPRI URD which is recognised internationally and within the UK as good practice. |
| Characterisation & Segregation | The Liquid Radwaste System employs at source segregation of the waste arisings. While this is done via the RDS which is not in the scope of this GDA, this design feature is present within the system design and segregates the waste arisings based on their conductivity levels. This design feature minimises solid waste volume arisings and allows for process flexibility to allow for individual processing of the segregated streams in the most efficient manner. This requirement originates from the EPRI URD. | EPRI URD Chapter 12, section 3.2.3.1 [42]. | While the RDS is not in scope, the design requirement stems from the EPRI URD and therefore is in keeping with UK good practice. |
| | The design of the SMR-300 is done such that the wastes are segregated based on their activity. The CVCS is used to process the high activity arisings from the primary circuit, minimising the volume of liquid waste which requires treating by the LRW. The LRW is only used when the water requires additional treating for discharge. By handling and processing the high activity wastes in a separate system and using the LRW only for treating effluent for discharge this adheres to the segregation principle and minimises the potential contamination of LRW piping and equipment with liquid effluent with high activity levels. | This does not have a direct link to a design code and standard. | While this is not a specific design requirement laid out within codes and standards. Operating the SMR-300 in this way aids in segregation of the liquid wastes in keeping with segregation of the radioactive wastes to minimise additional contamination of piping and equipment. |

To demonstrate the generic SMR-300 design takes cognisance of UK RGP, the GRW design requirements adopting or echoing internationally recognised codes and standards were identified. Table 14 below presents the links between these codes and standards to UK context and regulatory requirements and expectations.

**Table 14: GRW UK RGP Compliance Assessment**

| Overarching Grouping | GRW | | |
|---|---|---|---|
| | Holtec Requirement | Relevant C&S | UK Context Link |
| Containment and Confinement | The pressure relief devices on the GRW equipment shall be piped into the building exhaust ventilation system to provide an additional means for monitored containment. This is a requirement laid out within ANSI/ANS-55.4-1993 (R2007) [32] | ANSI/ANS-55.4-1993 (R2007) section 5.2.1.2.1 [32]. | This design requirement is placed on the SMR-300 design by an internationally recognised standard. This aligns it with UK RGP. Furthermore, this design feature directly aligns with ECV.4 as it provides additional containment barriers for the gaseous waste. It also aligns with ECV.2 as this design feature provides additional containment to minimise the potential for environmental release. |
| | The design of the piping and equipment for the GRW will be done in accordance with ANSI/ANS-55.4-1993 (R2007) [32] to minimise the potential for leakage from the system. This requirement is driven by the necessity to comply with 10 CFR 20.1406 [106] surrounding the minimization of contamination. This includes design features such as use of welding on the piping where practicable and selection of valves and equipment to minimise the potential for leakage. | ANSI/ANS-55.4-1993 (R2007) sections 4.4, 4.5, 4.9 & 5.2.7 [32]. | The design features implemented into the SMR-300 design originate from an internationally accepted standard for the design of gaseous radwaste systems. This aligns it with UK RGP. In addition, this requirement satisfies 10 CFR 20.1406 [106] around minimizing the spread of contamination which broadly aligns with ECV.1 with the design features being included specifically to mitigate against leakage in the system. |
| Monitoring | Continuous radiation and flow monitoring will be provided downstream of the GRW system on the discharge to the RAB plant vent.<br>Grab sampling will be available on the discharge. The proposed setup must also allow for periodic calibration of monitors and adequate sensitivity to detect non-compliance with limits in line with EPRI Section Chapter 12 2.4.4.2 [42] | ANSI/ANS-55.4-1993 section 5.5 [32]. | The monitoring of discharges downstream of abatement and upstream of any dilution is a core requirement of the EA.<br>This enables source identification during a release and reliable measurement of radionuclide concentrations and quantities in discharges. |
| Waste Minimisation | The selection of decay tanks as the abatement technology rather than delay beds which utilise activated charcoal prevents the generation of an additional secondary waste stream as the activated charcoal becomes radioactive after being used to adsorb the radionuclides from the gaseous effluent streams. This minimises the generation of additional solid waste. | EPRI URD Chapter 12, section B.1.2.3 [42]. | The selection of decay tanks as the abatement technology rather than delay beds which utilise activated charcoal avoids the generation of an additional secondary waste stream as the activated charcoal becomes radioactive after being used to adsorb radionuclides from the gaseous effluent streams. |

To demonstrate the generic SMR-300 design takes cognisance of UK RGP, the SRW design requirements adopting or echoing internationally recognised codes and standards were identified. Table 15 below presents the links between these codes and standards to UK context and regulatory requirements and expectations.

**Table 15: SRW UK RGP Compliance Assessment**

| Overarching Grouping | SRW | | |
|---|---|---|---|
| | Holtec Requirement | Relevant C&S | UK Context Link |
| Containment and Confinement | While the design of the spent filter cartridge transport vehicle has not been finalised, it is a requirement of the design to ensure that leakage from the filter transfer vehicle during the transporting of a filter assembly is prevented. | EPRI URD Chapter 12, section 4.4.5.7.2 | This design requirement is placed on the SMR-300 design by an internationally recognised standard. This aligns it with UK RGP. |
| | The number of penetrations on the waste containers shall be minimised to minimise the potential number of leak paths. While the specific conditioning equipment is yet to be defined, ensuring this requirement is in the design from this early stage will lead to reduced leak paths going forward. | EPRI URD Chapter 12, section 4.4.5.2.5 | This design requirement is placed on the SMR-300 design by an internationally recognised standard. This aligns it with UK RGP. |
| Monitoring | Spent filter cartridges are transported using suitably shielded filter transfer casks to designated areas where sampling and analysis can be safely performed before further treatment and disposal, maintaining ALARA exposure.<br>The methodology selected allows for very low exposure to operators whilst removing the filter from its original housing. Sampling capability for high activity cartridge filters is an EPRI requirement. | EPRI URD Chapter 12, section 4.4.5.7.5.2 | This design requirement is placed on the SMR-300 design by an internationally recognised standard. This aligns it with UK RGP. |
| | Spent resin tanks will be mixed by means of pumps to enable recirculation or forward feeding to dewatering.<br>The spent resin tanks also utilise a fluidised bed arrangement using compressed air from the CAI. | EPRI URD Chapter 12, section 4.4.5.5.3.2 | EPRI advises using eductor mixing to enable representative sampling from resin tanks. This approach also reduces variations in the radiation levels of arising spent resin containers through resin blending. |
| Waste Minimisation | Vertical liquid collection tanks for high solids liquid collection systems should be cylindrical with conical bottoms with the discharge and drain lines at the lowest point of the tanks. This will aid in the minimisation of the accumulation of sludges at the bottom of the tanks. | EPRI URD Chapter 12, section 3.4.5.9.5 | This requirement is based upon EPRI URD which is recognised internationally and within the UK as good practice. |

| Overarching Grouping | SRW | | |
|---|---|---|---|
| | Holtec Requirement | Relevant C&S | UK Context Link |
| | RG 8.8 provides design features intended to reduce accumulation of resins and sludges. This is highlighted as a requirement for the RAB building to be designed in accordance with RG 8.8. The design features to be included are things such as reducing the number of pipe fittings, avoiding low points and dead legs, using gravitational flow where practicable, having continuously sloped pipes and reducing the length of pipe runs. These requirements are echoed within ANSI/ANS 55.1 and EPRI URD as a basis for international RGP. | ANSI/ANS 55.1<br>EPRI URD Chapter 12, section 4.4.5.4.3 | The requirement stems from US regulatory requirements but is echoed within several sources of international good practice. |
| | The SRW slurry transfer piping shall be designed to exclude crud traps. Piping used in transporting of resins or filter bed media shall be adequately sloped to facilitate transport of them as per a requirement within the EPRI URD. This will minimise the potential for accumulation of radiation within the slurry piping. | EPRI URD Chapter 12, section 4.4.5.4.3 .7 | This requirement is based upon EPRI URD which is recognised internationally and within the UK as good practice. |
| | Slurry piping shall be provided with automatic flushing and a sufficient water volume to flush the pipes clean after each use. This will leave the piping free of solids which could cause plugging or accumulation of radioactive material within the piping. This is a requirement outlined within the EPRI URD. | EPRI URD Chapter 12, section 4.4.5.4.3 .13 | This requirement is based upon EPRI URD which is recognised internationally and within the UK as good practice. |
| | The RAB has a non-safety function associated with its operation to ensure compliance with 10 CFR 20.1101 and 10 CFR 20.1406 [106]. It is specified that the system will be designed to facilitate "minimization of accumulation of radioactive materials in resin and sludge treatment systems". | Section 5.4.1 of ANSI/ANS-55.1-2021. | While this requirement isn't explicitly stated within EPRI URD, there are many discussions concerning the avoidance of crud traps etc as this can lead to accumulation of radioactive materials. Additionally, this sentiment is echoed within Section 5.4.1 of ANSI/ANS-55.1-2021 where it states that valves and associated piping shall be designed for minimising pockets that might become crud traps. This sufficiently highlights that the principle of designing for minimisation of accumulation is contained within codes and standards deemed to be good practice internationally. |
| Characterisation & Segregation | The setup of the SRW spent resin tanks is such that different activity level of resin will be stored in separate tanks. This provides segregation between higher level CVC and SFC resins compared to those arising from the LRW demineralisers. | EPRI URD Chapter 12, section 4.4.2.3.3 | The requirement stems from US regulatory requirements but is echoed within several sources of international good practice. |

## Appendix C US – UK Regulatory Alignment Statements

Table 16 below presents a summary of the alignment between the generic SMR-300's radioactive waste management arrangements and the ONR SAPs relevant to this chapter.

**Table 16: US – UK Regulatory Alignment Statements**

| SAP Number and Title | | Alignment Statement |
|---|---|---|
| RW.1 | Strategies for radioactive waste | Through development of the IWS and engagement with NWS on their expert view, there are no problematic wastes anticipated to be generated by the SMR-300. A high-level strategy for the management of all waste arisings has been proposed within the IWS such that at this stage of fundamental assessment, the generic SMR-300 is aligned with RW.1. The IWS is a live document which will be updated as design development progresses to ensure alignment is maintained. |
| RW.2 | Generation of radioactive waste | Through demonstration of the inclusion of design principles across the generic SMR-300 intended to prevent the generation of radioactive waste where possible and minimise elsewhere, it can be said that the generic SMR-300 is aligned with RW.2 commensurate with the expected level of detail for fundamental assessment. |
| RW.3 | Accumulation of radioactive waste | Minimisation of accumulation of radioactive waste on-site is dependent on both the overall waste management strategy as well as the specific packaging and storage arrangements for the radioactive waste arisings. The strategy presently identifies no problematic wastes that may become a site based legacy wastes and where no immediate disposal route is available such as with operational ILW, this is dealt with through on-site interim storage which does not constitute accumulation. Additional information on the characteristics of waste are to be determined to identify the optimal management strategies and the design of LLW and ILW facilities (GDA Commitment C_RWMA_078). There is significant confidence that on-site accumulation of radioactive waste will be minimised. |
| RW.4 | Characterisation and segregation | Characterisation and segregation of waste is an area which is known to have relevant discrepancies between the generic SMR-300 design and the UK regulatory requirements. As part of GDA Commitment C_RWMA_078, work will be undertaken to assess the arrangements for characterisation, sorting and segregation for radioactive waste within the RAB. This will allow for several options to be considered, and a solution selected to ensure alignment with UK regulatory requirements. This is not seen as a fundamental issue with the assessment of the generic SMR-300 at this stage. |
| RW.5 | Storage of radioactive waste and passive safety | Radioactive waste storage and passive safety are also known gaps between the regulatory regimes of the US and the UK. These differences led to the design challenge being raised and subsequently the GDA Commitment (C_RWMA_078) surrounding the design of the on-site interim store. There is significant confidence that all radioactive wastes will be capable of being stored in a passively safe state as soon as is reasonably practicable. |
| RW.6 | Passive safety timescales | Storage of radioactive waste in a passively safe state as soon as is reasonably practicable is a known gap between the regulatory regimes of the US and the UK. These differences led to the Design Challenge being raised and subsequently the GDA Commitment that sets the design of the on-site interim store and BAT / ALARP optioneering of the ILW management process. Therefore, while full alignment with this SAP cannot be confirmed presently, through production of the ILW Management Options Assessment and undertaking work associated with the GDA Commitment, there is significant confidence that all radioactive wastes will be capable of being stored in a passively safe state as soon as is reasonably practicable. |
| ECV.1 | Prevention of leakage | Through assessment of the design of the radioactive waste management SSCs and review of relevant design codes and standards, there is confidence that suitable measures are present in the generic SMR-300 design to prevent the leakage of radioactivity. Examples of these design details can be found within Appendix B. As the design develops, additional evidence will be presented to strengthen the alignment of the generic SMR-300 with ECV.1. |
| ECV.2 | Minimisation of releases | Through assessment of the design of the radioactive waste management SSCs and review of the relevant design codes and standards, there is confidence that suitable measures are included within the generic SMR-300 design to minimise releases of radioactivity. Examples of these design details can be found within Appendix B. As the design develops, additional evidence will be presented to strengthen the alignment of the generic SMR-300 with ECV.2. |

| SAP Number and Title | | Alignment Statement |
|---|---|---|
| ECV.3 | Means of confinement | Through assessment of the design of the radioactive waste management SSCs and review of the relevant design codes and standards, there is confidence that suitable measures are included within the generic SMR-300 design to appropriately confine radioactivity. Examples of these design details can be found within Appendix B. While the examples presented in Appendix B are not all encompassing, as the design develops, additional evidence will be presented to strengthen the alignment of the generic SMR-300 with ECV.3. |
| ECV.4 | Provision of further containment barriers | In addition to the measures outlined to provide confinement of radioactivity for the radioactive waste management SSCs there are features included within the design of the generic SMR-300 which provide additional containment barriers to the existing plants items performing containment functions, for example the provision of berms in the LRW. Additional evidence will be presented to strengthen the alignment of the generic SMR-300 with ECV.4. |
| ESR.8 | Monitoring of radioactive material | Details on the instrumentation provided for the monitoring of leaks or escapes of radioactive material is not fully developed at this stage of the design. Notwithstanding, there are key examples of monitoring and leak detection devices contained within the design documentation for the generic SMR-330 radioactive waste SSCs. These examples demonstrate that at a high level there is provision for monitoring equipment. This will be supplemented by additional design detail as the design progresses. |
| ECV.6 | Monitoring Devices | Details on the monitoring devices provided for detecting and assessing changes in the materials contained within the scope of the radioactive waste SSCs is not fully developed at this stage of the design. Identification of monitoring device and high-level alarms is present within the design documentation for the LRW, GRW and SRW. These examples demonstrate that at a high level there is provision for monitoring devices. This will be supplemented by additional design detail as the design progresses. |
| ECV.7 | Leakage Monitoring | Leakage monitoring for the radioactive waste management SSCs hasn't been fully developed at this stage of design. The systems have been designed in accordance with internationally recognised codes and standards which outline the requirements for leakage monitoring. Therefore, there is confidence that suitably robust leakage monitoring systems shall be implemented within the design of the generic SMR-300 as the design develops. |