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Title

# E3S Case Chapter 11: Management of Radioactive Waste


## Executive Summary

This chapter of the Environment, Safety, Security, and Safeguards (E3S) Case presents the Management of Radioactive Waste of the Rolls-Royce Small Modular Reactor (RR SMR). The report outlines the arguments and preliminary evidence available at the Preliminary Concept Definition (PCD) design stage to underpin the high-level Claim that the RR SMR systems for the handling, minimising, conditioning, storing, and disposing of radioactive waste, are designed and substantiated to achieve their functional and non-functional safety requirements, and reduce risks to As Low As Reasonably Practicable (ALARP).

The sources of solid, liquid, and gaseous waste streams for the RR SMR are summarised, noting the anticipated quantities, arrangements for waste minimisation, and disposal routes in E3S Case Chapters 26 and 29. The systems for management of waste streams are described in this chapter:

1. Processing & Treatment System for Liquid Radioactive Effluent [KNF]

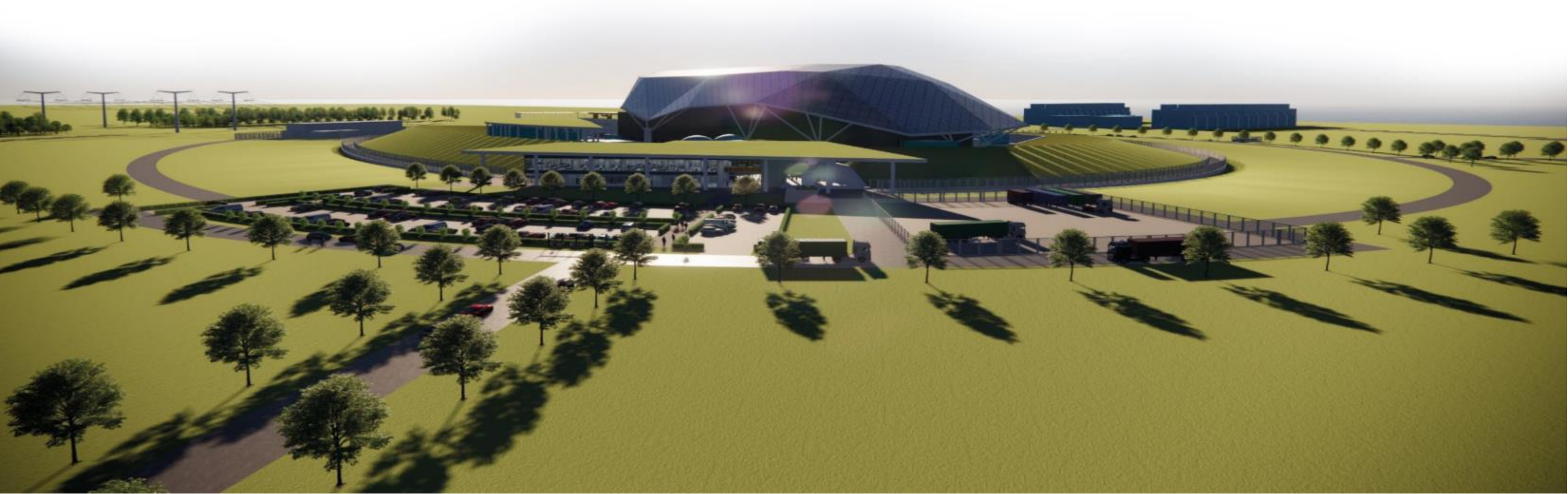
2. Processing and Treatment System for Gaseous Radioactive Effluent [KPL]

3. Solid Waste Treatment System [KM]

4. Reactor Island Collection and Drainage System [KTA]

For each system, the design solutions at PCD are presented, including architecture, materials, operation, Control & Instrumentation, and Examination, Maintenance, Inspection and Testing (EMIT) arrangements, to meet the anticipated safety requirements.



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# 11.0 Introduction

## 11.0.1 Introduction to Chapter

Chapter 11 of the Rolls-Royce Small Modular Reactor (RR SMR) Environment, Safety, Security & Safeguards (E3S) Case forms part of the Pre-Construction Safety Report (PCSR) and is a supporting reference to the Generic Environment Report (GER) and Generic Security Report (GSR), as defined in E3S Case Chapter 1: Introduction, Reference [1].

Chapter 11 presents the overarching summary and entry point to the design information for the solid, liquid and gaseous radioactive waste systems for the Rolls-Royce Small Modular Reactor (RR SMR), as defined at Reference Design (RD) 5 level of design maturity.

## 11.0.2 Scope

The scope of this chapter covers the design of Structures, Systems and Components (SSCs) for management of the anticipated RR SMR waste streams. The list of SSCs that are included in the scope of this chapter is provided in Section 11.8 (Appendix B). For each SSC in scope, the following aspects are summarised:

1. High-Level Safety Functions (HLSFs) delivered by the SSC, and the assigned safety categorised functional requirements and non-functional system requirements

2. Design description, including architecture, layout, operating modes, As Low as Reasonably Practicable (ALARP) and Best Available Technique (BAT) considerations in the design development

3. Key verification activities and evidence to support substantiation of SSCs

Environment and Security Functional Requirements for SSCs will be reported in the GER and the GSR respectively and are not included in the scope of the PCSR.

The scope of this report also includes a brief overview of the expected sources of solid, liquid, and gaseous waste streams for the RR SMR. Detail of the anticipated quantities of solid waste, and strategies for minimisation and disposal of all wastes, are covered in E3S Case Chapter 26: Radioactive Waste Management Arrangements, Reference [2]. Furthermore, the anticipated quantities of liquid and gaseous waste are covered in E3S Case Chapter 29: Quantification of Radioactive Effluent Discharges and Proposed Limits, Reference [3].

***Design/Programme Maturity***

RR SMR design information presented in this revision of the PCSR is largely based on the design definition at the end of Preliminary Concept Definition (PCD), which is an interim design stage representing RD5 level of design maturity. At PCD, the maturity of the SSCs presented for the radioactive waste systems is limited. Further evidence will be generated (see Section 11.0.3), including definition of the safety categorised functional requirements and non-functional system requirements for all waste systems. Further design development and definition of waste systems is in progress, to achieve requirements, and ultimately substantiation of requirements.

## 11.0.3 Claims, Arguments, Evidence Route Map

The Chapter level Claim for E3S Case Chapter 11: Management of Radioactive Waste is:

***Claim 11: The RR SMR systems for the handling, minimising, conditioning, storing, and disposing of radioactive waste, are designed and substantiated to achieve their functional and non-functional safety requirements, and reduce risks to As Low As Reasonably Practicable***

A decomposition of this Claim into Sub-Claims, Arguments, and link to the relevant Tier 2 Evidence is provided in Appendix A. For each lowest level Sub-Claim, the sections of this report providing the Evidence summary are also identified.

The complete suite of evidence to underpin the Claims in the E3S Case will be generated through the RR SMR design and E3S Case programme and documented in the Claims, Arguments, Evidence (CAE) Route Map, Reference [4], described further in E3S Case Chapter 1: Introduction, Reference [1].

## 11.0.4 Applicable Regulations, Codes & Standards

The Relevant Good Practice (RGP) applicable to radioactive waste management includes:

1. International Atomic Energy Agency (IAEA) SSR-2/1, Reference [5]
2. IAEA Safety Standards, Predisposal Management of Radioactive Waste, GSR Part 5, Reference [6]
3. Office for Nuclear Regulation (ONR) Safety Assessment Principles, Reference [7]
4. Environment Agency (EA) Radioactive Substance Regulation (RSR): objective and principles, Reference [8]
5. RSR generic developed principles: regulatory assessment, Reference [9]
6. Guidance on applying the Waste Hierarchy, Reference [10]

Further description of RGP relevant to radioactive waste management is provided in E3S Case Chapter 26: Radioactive Waste Management Arrangements, Reference [2].

The mechanical systems and components summarised in this report are designed in accordance with their safety classification, to the codes and standards outlined in Table 11.0-1, as identified in Reference [11].

**Table 11.0-1: Mechanical Design Codes & Standards**

| Safety Classification | Design Basis Code |
|---|---|
| Very High Reliability (VHR) | American Society of Mechanical Engineers (ASME) III (Sub-section NB) and beyond code requirements |
| High Reliability (HR) | ASME III (Sub-section NB) and beyond code requirements |

| Safety Classification | Design Basis Code |
|---|---|
| Class 1 | ASME III |
| Class 2 | ASME III |
| Class 3 | ASME III or Commercial standards e.g., ASME VIII, British Standard (BS) EN 13445 |
| n/a | Commercial standards e.g., ASME VIII, BS EN 13455 |

# 11.1 Sources of Radioactive Waste

## 11.1.1 Sources of Waste

At PCD, an overview of the wastes expected to be generated by RR SMR during plant operation have been identified and summarised in Table 11.1-1, based on information presented in the Integrated Waste Strategy, Reference [12].

**Table 11.1-1: Operational Waste Descriptions and Definitions**

| Waste Category | Definition of Waste Category | Waste Type / Source |
|---|---|---|
| **Radioactive Wastes** | | |
| Spent Fuel (SF) | Nuclear fuel that has been used in a nuclear reactor (becomes radioactive waste at the point that it is packaged for disposal) | • SF assemblies<br>• Failed fuel assemblies |
| Dry solid High-Level Waste (HLW) | Waste that has a radioactive content exceeding 4GBq per tonne of alpha, or 12GBq per tonne of beta or gamma activity, and has a significant heat output | Neutron flux detectors |
| Dry Solid Intermediate-Level Waste (ILW) | Waste that has a radioactive content exceeding 4GBq per tonne of alpha, or 12GBq per tonne of beta or gamma activity, and does not have a significant heat output | • Miscellaneous operational waste/dry active waste (e.g., metal components from maintenance)<br>• Activated metallic reactor components<br>  ◦ Control rods<br>  ◦ Thimble plugs<br>  ◦ Fixed neutron sources<br>  ◦ Core Outlet Thermocouple (COT) lances<br>  ◦ Ultrasonic filters (if ultrasonic fuel cleaning is used) |

| **Waste Category** | **Definition of Waste Category** | **Waste Type / Source** |
|---|---|---|
| Wet Solid ILW | | • Resins<br>  • The resins waste stream originates from the Chemistry and Volume and Control System (CVCS) [KB] and Fuel Pool Purification System [FAL]<br>  • This includes resins found to be unsuitable for decay storage and disposal as Low Level waste (LLW)<br>• Suspended Filter Solids originating from the back-washing of the CVCS [KB] and Fuel Pool Purification System [FAL] filters<br>• Sludges |
| Wet Solid Boundary Low-Level Waste (LLW)/ILW Wastes | Resins and concentrates above the ILW threshold at point of generation but are expected to be below the LLW threshold after decay and processing. | • Spent Liquid Effluent Treatment system resins<br>• Evaporator concentrate from spent liquid effluent treatment system |
| Dry Solid LLW | LLW – waste below the ILW threshold | • Pool skimmers<br>• Filters from gas treatment system – High Efficiency Particulate Air (HEPA) filters and iodine traps<br>• Reverse Osmosis (RO) membranes from spent liquid effluent treatment system<br>• Operational waste (e.g., replaced components, bags, and general waste from controlled areas)<br>• Metallic wastes (e.g., replaced equipment)<br>• Spent charcoal (from delay beds/iodine traps)<br>• Spent catalysts from the recombiner |
| Wet Solid LLW | | • Miscellaneous sludge from tanks and sumps – not expected in normal operations<br>• Oils and solvents e.g., scintillation liquids, and solvents from decontamination in the Radiologically Controlled Area (RCA)<br>• Evaporator concentrate from spent liquid effluent treatment system |

| Waste Category | Definition of Waste Category | Waste Type / Source |
|---|---|---|
| Reusable Liquid Radioactive Effluents | Liquid effluent that has radioactive content and can be reused in the plant | • Primary coolant bleed (when required for chemistry and inventory control)<br>• Spent effluent streams including process, floor and chemical drains (e.g., drainage of equipment, floor washings, chemical sampling, and decontamination effluents) |
| Non-Reusable Liquid Radioactive Effluents | Liquid effluent that has radioactive content and cannot be reused in the plant and therefore requires discharge | Primary coolant bleed with high tritium content (e.g., following a fuel failure event) |
| Gaseous Radioactive Effluents | Gaseous effluent that has radioactive content | • Treated off-gases from the primary circuit<br>• Treated Heating, Ventilation and Air Conditioning (HVAC) System [KL] effluents containing airborne radioactive particulate from contaminated plant atmospheres |

### 11.1.2 Quantities of Waste

A summary of the anticipated annual solid waste volumes and package numbers for RR SMR is provided in E3S Case Chapter 26: Radioactive Waste Management Arrangements, Reference [2], and the anticipated liquid and gaseous waste quantities are summarised in E3S Case Chapter 29: Quantification of Radioactive Effluent Discharges and Proposed Limits, Reference [3].

### 11.1.3 Disposal of Waste

It is expected that SF and HLW/ILW will be retained on site in storage for an extended period following the active decommissioning phase, prior to their disposal to the Geological Disposal Facility (GDF). LLW streams will be processed for disposal at the Low-Level Waste Repository (LLWR) or incineration via Nuclear Waste Services (NWS).

The management strategies for all RR SMR waste streams through the lifetime of the plant are summarised in E3S Case Chapter 26: Radioactive Waste Management Arrangements, Reference [2].

### 11.1.4 Minimisation of Generation & Accumulation of Waste

A summary of the radioactive waste management strategy, principles and arrangements, which include the application of BAT and the waste hierarchy principles in the design process, are summarised in E3S Case Chapter 26: Radioactive Waste Management Arrangements, Reference [2]. These ensure that wastes are eliminated at source, or where this is not possible, that wastes are minimised as far as possible.

# 11.2 Systems for Management of Liquid Radioactive Waste

## 11.2.1 System & Equipment Functions

The primary function of the Processing & Treatment System for Liquid Radioactive Effluent [KNF] is to collect and treat radioactive liquid effluents to make them suitable for recycle or discharge. The system supports delivery of the Fundamental Safety Function (FSF) of Confinement of Radioactive Material (CoRM).

## 11.2.2 Safety Design Bases

Safety Functional Requirements

At PCD, safety categorised functional requirements and associated non-functional performance requirements for the Processing & Treatment System for Liquid Radioactive Effluent [KNF] based on the HLSFs they deliver are still to be developed.

Non-Functional System Requirements

At PCD, non-functional system requirements for the Processing & Treatment System for Liquid Radioactive Effluent [KNF] are still to be developed.

A full set of non-functional system requirements are in development based on the E3S Principles, which will be systematically applied to each SSC as part of the systems engineering process.

Safety Classification

At PCD, the safety categorisation and classification for the Processing & Treatment System for Liquid Radioactive Effluent [KNF], is still to be developed.

The seismic classification of SSCs is still to be assigned in accordance with methodology outlined in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [13].

## 11.2.3 Description

The Processing & Treatment System for Liquid Radioactive Effluent [KNF] collects liquid radioactive effluents in tanks and treats them with a combination of separation methods for removal of radionuclides and chemical contaminants. The treatment that the Processing & Treatment System for Liquid Radioactive Effluent [KNF] will undertake will enable the storage and recycling of treated effluents, or if unsuitable for this, effluents may be discharged to the environment (subject to permit and BAT). The system manages both primary and spent liquid effluent and treats them based on their characterisation (expected or measured levels of radiological and chemical contamination).

The baseline key performance and design parameters are presented in Table 11.2-1.

**Table 11.2-1: Key System Design and Performance Parameters for [KNF]**

| Parameter | Value | Note |
|---|---|---|
| System Flow Rate | **{REDACTED FOR PUBLICATION}** | Varies for each effluent treatment operation |
| Design Temperature | **{REDACTED FOR PUBLICATION}** | Mostly low temperature processes and ambient conditions |
| Design Pressure | **{REDACTED FOR PUBLICATION}** | Mostly low pressure processes and ambient conditions |
| Operating Temperature | **{REDACTED FOR PUBLICATION}** | - |
| Operating Pressure | **{REDACTED FOR PUBLICATION}** | - |

The Processing & Treatment System for Liquid Radioactive Effluent [KNF] is located in Reactor Island [R01] in the south auxiliary building, and comprises:

1. Processing & Treatment System for Primary Liquid Effluent [KNF10], which collects primary liquid effluent in storage tanks. The sources of effluent are the transfer of reactor coolant from the (CVCS) [KB] letdown, drainage to the reactor coolant drain tank and treated spent liquid effluent from treatment systems [KNF20] transferred for recycle. The sub-system contains:

   a. Storage tanks for primary liquid effluent, with transfer pumps and connection to sampling systems [KU] and treatment systems [KNF20]

   b. A vacuum degasser for removal of dissolved gases from effluent and make-up water

2. Processing & Treatment System for Spent Liquid Effluent [KNF20], which collects spent liquid effluent in storage tanks. The sources of effluent are the process, chemical and floor drains, collected from a variety of sumps and vessels in the collection and drainage systems [KTA]. The sub-system contains:

   a. Storage tanks for process, chemical and floor drains, with transfer pumps and connection to sampling systems [KU]

   b. Storage tanks for chemical drains with one tank aligned to collect retentates from the RO process, with transfer pumps and connection to sampling systems [KU]

   c. Abatement and further volume reduction of effluents:

      i. Backwashable pre-filters to protect downstream components

      ii. RO process using membrane separation to separate a purified permeate from a concentrated retentate

      iii. Ion Exchange (IEX) polishing in resin beds to demineralise permeate from upstream RO process

iv. Vacuum waste evaporator for further abatement and volume reduction of retentate from upstream RO process

3. Liquid Effluent Monitoring and Discharge System [KNF30], for collection, recycle or discharge of treated liquid effluents. The sub-system contains:

   a. Active monitoring tanks for treated liquid effluent, with transfer pumps and connection to sampling systems

   b. Discharge line to the Cooling Water Island outfall, with sampling and monitoring

   c. Recycle line to distribute as primary make up water, demineralised water in Reactor Island [R01] and to the CVCS [KB] or SF pool systems

Further details of the design of each sub-system and components are provided in the System Outline Description, Reference [14].

### 11.2.4 Materials

Materials for the Processing & Treatment System for Liquid Radioactive Effluent [KNF] will be selected to minimise risks associated with operator and maintenance dose, corrosion, and decommissioning. At PCD, stainless steel is selected for the design of components in contact with radioactive liquid effluent. The vacuum evaporator will require specific material selection due to elevated corrosion risk.

The description and justification of materials used for classified SSCs are presented in E3S Case Chapter 23: Structural Integrity, Reference [15].

### 11.2.5 Interfaces

The Processing & Treatment System for Liquid Radioactive Effluent [KNF] key functional and physical interfaces include connections to the Sampling System [KU] for effluent characterisation upon collection. The system removes dissolved gases to be managed as gaseous effluent in the Processing and Treatment for Gaseous Radioactive Effluent [KPL]. The system generates solid waste to be processed for disposal in the Solid Radioactive Waste Processing Systems [KM].

All interfaces are identified and managed within the RR SMR requirements management system Dynamic Object-Orientated Requirements System (DOORS), including flow down of functional requirements, and are listed in the System Outline Description, Reference [14].

### 11.2.6 System & Equipment Operation

The Power Station Operating Philosophy, Reference [16] provides the overarching information on how the plant and operator maintain control of key functions across the six defined operating modes, including the operating principles, required actions, means for transitioning between the operating modes, and relevant safety systems for each mode. This is summarised in E3S Case Chapter 13: Conduct of Operations, Reference [17].

Most of the Processing & Treatment System for Liquid Radioactive Effluent [KNF] operations (during all normal operating modes) are batch-based and manually actuated from the Main

Control Room (MCR) through alignment of system configurations. Process controls for equipment mostly result in fail-safe trips without alarms to minimise operator burden.

Operations include:

1. Coolant letdown; effluent will be received from the CVCS [KB] letdown on demand, primarily during reactor start-up transients resulting in thermal expansion, and bleed and feed operations

2. Primary circuit make-up; deaerated make-up water will be supplied to the CVCS [KB] periodically, with additional make-up required for thermal contraction of the primary circuit during shutdown transients

3. Spent liquid transferred to Processing & Treatment System for Spent Liquid Effluent [KNF20] from the collected process, chemical and floor drains when upstream vessels in Reactor Island Collection and Drainage System [KTA] are filled

4. Sampling of effluent tanks, including effluent characterisation of Processing & Treatment System for Spent Liquid Effluent [KNF20] and Liquid Effluent Monitoring and Discharge System [KNF30] prior to transfers due to higher variability in contaminants

5. Effluent discharge

Process flowcharts for normal system operation are presented in Reference [14].

### 11.2.7 Instrumentation & Control

The Reactor Control and Instrumentation (C&I) System [JY] is required to provide control of functions performed by the Processing & Treatment System for Liquid Radioactive Effluent [KNF], including automatic opening/closing of valve and pump configurations that are manually initiated in the MCR.

The Reactor C&I System [JY] will also monitor a range of key system parameters and provide indication of these to the operator in the control room and in the emergency control centre. It will also provide alarms to indicate that key system parameters are outside of the defined performance bands and/or safety limits. The envisaged requirements for monitoring, indication, alarms, and warnings are specified in the System Outline Description, Reference [14].

The allocation of safety categorised functional requirements from the Processing & Treatment System for Liquid Radioactive Effluent [KNF] to the Reactor C&I System [JY] will be presented in the C&I Engineering Schedule, described further in E3S Case Chapter 7: Instrumentation & Control, Reference [18].

### 11.2.8 Examination, Maintenance, Inspection & Testing

Maintenance of the Processing & Treatment System for Liquid Radioactive Effluent [KNF] is not expected to occur during refuelling outages, when processing duty is expected to be highest as various systems in Reactor Island [R01] perform drainage or letdown.

An outline maintenance plan for the Processing & Treatment System for Liquid Radioactive Effluent [KNF] is still to be developed. This will include consideration of nitrogen purging for equipment handling primary liquid effluent prior to maintenance and inspection, increased maintenance and remote cleaning of the waste evaporator during the plant life, and use of demineralised water for washing and flushing.

### 11.2.9 Radiological Aspects

Minimisation of normal operation and maintenance doses to ALARP is one of the key design criteria in the systems engineering design decision process, see Section 11.2.12.

Opportunities to reduce radiological exposures during normal operation and maintenance have been considered within the design at PCD, such as the design of liquid effluent tanks with suitable materials and structure (e.g., sloping bottom towards the pump suction line) to minimise accumulation of particulates that could increase operator exposures during inspections and maintenance.

### 11.2.10 Preliminary Substantiation

Verification activities to substantiate safety categorised functional requirements and non-functional system requirements for the Processing & Treatment System for Liquid Radioactive Effluent [KNF] are still to be determined.

### 11.2.11 Installation & Commissioning

An outline installation and commissioning plan for the Processing & Treatment System for Liquid Radioactive Effluent [KNF] is still to be developed. The overall strategy for the RR SMR commissioning programme is presented in E3S Case Chapter 14: Plant Construction & Commissioning, Reference [19].

### 11.2.12 ALARP in Design Development

The design of the Processing & Treatment System for Liquid Radioactive Effluent [KNF] is being developed in accordance with the systems engineering design process, which includes alignment to RGP and Operating Experience (OPEX), design to codes and standards according to the safety classification (to be confirmed), and a systematic optioneering process with down-selection of design options based on assessment against relevant safety criteria (as described in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [13]).

Processing & Treatment System for Liquid Radioactive Effluent [KNF] design decisions made with respect to ensuring overall risks are reduced to ALARP include:

1. Merging of effluent treatment trains for primary and spent effluent (Processing & Treatment System for Primary Liquid Effluent [KNF10] and Processing & Treatment System for Spent Liquid Effluent [KNF20]), which reduces the equipment in the system resulting in a reduced maintenance burden and thus potential operator exposure

2. Selection of a vacuum evaporator with reduced temperature and pressure to decrease corrosion risk, and provision of temperature, pressure and flow trips to minimise potential for loss of containment of highly concentrated effluents from the evaporator

More detailed information on design decisions is presented in the System Outline Description, Reference [14]. Design decisions are also reviewed against criteria for BAT to reach an optimised position. The BAT aspects of design decisions for the Processing & Treatment System for Liquid Radioactive Effluent [KNF] are presented in E3S Case Chapter 27: Demonstration of BAT, Reference [20].

### 11.2.13 Ongoing Design Development

The RR SMR design definition is currently in development as described in Section 11.0.2. Development of the Processing & Treatment System for Liquid Radioactive Effluent [KNF] and will be informed by safety categorised functional requirements and non-functional system requirements placed onto the design as the safety analysis is developed.

# 11.3 Systems for Management of Gaseous Radioactive Waste

## 11.3.1 System & Equipment Functions

The primary function of the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] is to process gaseous effluent from the primary circuit containing hydrogen and volatile fission products. The system supports delivery of the FSF of CoRM.

## 11.3.2 Safety Design Bases

Safety Functional Requirements

At PCD, safety categorised functional requirements and associated non-functional performance requirements for the Processing and Treatment for Processing and Treatment System for Gaseous Radioactive Effluent [KPL] based on the HLSFs they deliver are still to be developed.

Non-Functional System Requirements

At PCD, non-functional system requirements for the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] are still to be developed.

A full set of non-functional system requirements are in development based on the E3S Principles, which will be systematically applied to each SSC as part of the systems engineering process.

Safety Classification

At PCD, the safety categorisation and classification for the Processing and Treatment System for Gaseous Radioactive Effluent [KPL], is still to be developed.

The seismic classification of SSCs is still to be assigned in accordance with methodology outlined in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [13].

## 11.3.3 Description

The Processing and Treatment System for Gaseous Radioactive Effluent [KPL] uses nitrogen cover gas to purge interfacing systems handling reactor coolant, primary circuit effluent or make-up water. Hydrogen and volatile fission products (xenon and krypton) in vessel/tank headers are purged by the cover gas and collected as gaseous effluent.

The key sources of these gases during power operation are the vacuum degasser in the Processing & Treatment System for Liquid Radioactive Effluent [KNF] and reactor coolant drain tank in the Collection & Drainage System [KTA]. Air ingress is minimised to prevent formation of flammable atmospheres and prevent aeration of primary circuit water.

Most of the nitrogen cover gas is recycled in a semi-closed loop. Excess gas during volume surges such as tank filling operations is directed to the delay beds where the fission product gases are abated through hold-up and decay. Cover gas is delivered by compressors and distributed via a combination of pressure and flow control.

Hydrogen and oxygen content in the gas stream are constantly measured through analysers and are abated via the recombiner. Gas cooling and drying is required to minimise moisture content, ensuring the performance of the recombiner and the charcoal delay beds.

The baseline key performance and design parameters are derived from standard Pressurised Water Reactor (PWR) practice, presented in Table 11.3-1. Normalised conditions for gases in the system are defined as **{REDACTED FOR PUBLICATION}**.

**Table 11.3-1: Key System Design and Performance Parameters for [KPL]**

| Parameter | Value | Note |
|---|---|---|
| No. of Gas compressors | **{REDACTED FOR PUBLICATION}** | Duty / stand-by operation to allow maintenance and inspection of compressors while [KPL] continues operation |
| Gas compressor flow rate | **{REDACTED FOR PUBLICATION}** | Subject to supplier feedback for achievable flow rates, as well as internal hazard management strategy<br>Sizing margin is proposed to maintain $H_2$ and $O_2$ concentrations below the operational limits of **{REDACTED FOR PUBLICATION}** without impacting compressor design |
| Gas compressor power | **{REDACTED FOR PUBLICATION}** | - |
| Discharge flow rate | **{REDACTED FOR PUBLICATION}** | No requirements currently specified for the flow rate through the delay beds other than the maximum flow rate expected through [KNF10] tank filling |
| Delay bed volumes | **{REDACTED FOR PUBLICATION}** | - |
| Operating temperature | **{REDACTED FOR PUBLICATION}** | Off-gas from the [KNF] degasser is specified to be cooled to **{REDACTED FOR PUBLICATION}** prior to exhaust. Other off-gases are expected to be cooled to **{REDACTED FOR PUBLICATION}**<br>Recombiner lower operating temperature specified as a system requirement to prevent condensation. Upper temperature derived from OPEX<br>Delay bed temperature subject to supplier feedback (as temperature impacts performance) |

**Table 11.3-1: Key System Design and Performance Parameters for [KPL]**

| Parameter | Value | Note |
|---|---|---|
| Operating pressure | **{REDACTED FOR PUBLICATION}** | Cover gas pressure range proposed to minimise air ingress<br>Delay bed pressure subject to supplier feedback (as pressure impacts performance) |

The baseline architecture of the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] comprises of:

1. A cover gas network distributing nitrogen to various interfacing systems handling primary circuit water (effluent or make-up)

2. A catalytic recombiner for $H_2$ and $O_2$ abatement, where the effluent stream is cooled and excess moisture is removed and drained

3. Gas analysers and gas injection supplies constantly controlling the $H_2$ and $O_2$ content

4. Two gas compressors with liquid seal systems, allowing for duty/standby operation as Processing and Treatment System for Gaseous Radioactive Effluent [KPL] is expected to operate continuously. The liquid seal is a closed circuit with a drum required for both buffer storage and separation of excess water, and a heat exchanger required for cooling. A surge gas line is proposed for recirculating flow when low compressor suction pressure is detected, to avoid spurious trips

5. Control valves for controlling pressure and distributing the gaseous effluent flow

6. A series of delay beds with an exhaust to the stack via the Heating, Ventilation, and Air Conditioning (HVAC) System [KL]. A dryer package protecting for moisture and a guard bed (proposed for contingency) upstream protects the delay beds from pollutants, e.g., halogens

A block flow diagram highlighting the key processes is shown below in Figure 11.3-1.

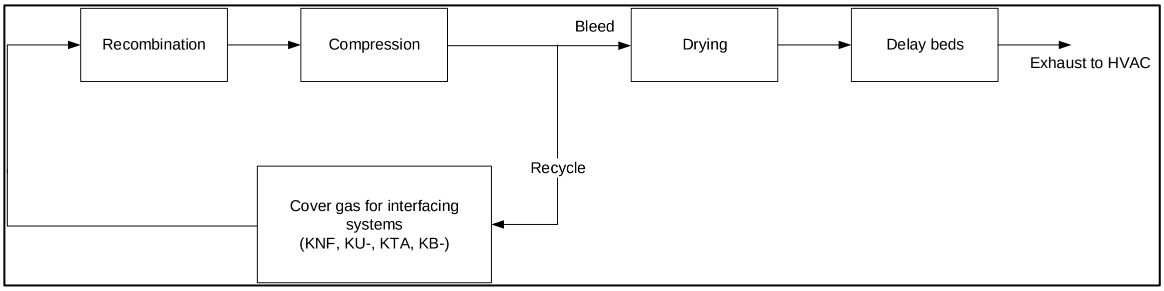


**Figure 11.3-1: Block Flow Diagram for Gaseous Waste Treatment System [KPL]**

The key Processing and Treatment System for Gaseous Radioactive Effluent [KPL] equipment is in the Auxiliary Building. The cover gas header lines interface with systems in the reactor containment building and auxiliary buildings. The effluent discharge connects to the stack.

Further details for the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] and associated sub-systems and components are provided in the System Outline Description, Reference [21].

### 11.3.4 Materials

Materials for the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] will be selected to minimise risks associated with operator dose, corrosion, and decommissioning. At PCD, stainless steel is selected for the design of components in contact with radioactive gaseous effluent.

The description and justification of materials used for classified SSCs are presented in E3S Case Chapter 23: Structural Integrity, Reference [15].

### 11.3.5 Interfaces

The Processing and Treatment System for Gaseous Radioactive Effluent [KPL] functional and physical interfaces are described above, including key interfaces with the Processing & Treatment System for Liquid Radioactive Effluent [KNF], reactor coolant drain tank, and HVAC System [KL]. All interfaces are identified and managed within DOORS, including flow down of functional requirements.

### 11.3.6 System & Equipment Operation

The Power Station Operating Philosophy, Reference [16] provides the overarching information on how the plant and operator maintain control of key functions across the six defined operating modes, including the operating principles, required actions, means for transitioning between the operating modes, and relevant safety systems for each mode. This is summarised in E3S Case Chapter 13: Conduct of Operations, Reference [17].

The Processing and Treatment System for Gaseous Radioactive Effluent [KPL] operations (during all normal operating modes) will be manually actuated from the MCR through alignment of system configurations. Current system configurations include switchover of duty/stand-by compressor packages and switchover of duty/standby control valves.

The Processing and Treatment System for Gaseous Radioactive Effluent [KPL] will be operating continuously during power operation, with the highest duty on the recombiner during reactor coolant degassing, expected when preparing for the shutdown transient or following design basis fuel failure. The highest duty on the delay beds is when preparing reactor coolant make-up water, and during thermal expansion and steam bubble formation in the primary circuit during start-up operations.

### 11.3.7 Instrumentation & Control

The Reactor C&I System [JY] is required to provide control of functions performed by the Processing and Treatment System for Gaseous Radioactive Effluent [KPL], including grouped commands for aligning the system isolation valves and actuators.

The Reactor C&I System [JY] will also monitor a range of key system parameters and provide indication of these to the operator in the control room. It will also provide alarms to indicate that key system parameters are outside of the defined performance bands and/or safety limits.

The envisaged requirements for monitoring, indication, alarms, and warnings are specified in the System Outline Description, Reference [14].

The allocation of safety categorised functional requirements from the grouped commands for aligning the system isolation valves and actuators to the Reactor C&I System [JY] will be presented in the C&I Engineering Schedule, described further in E3S Case Chapter 7: Instrumentation & Control, Reference [18].

## 11.3.8 Examination, Maintenance, Inspection & Testing

Maintenance of the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] is expected to be carried online where possible to provide nitrogen cover gas almost continuously until the system is shut down for statutory maintenance.

Online maintenance is enabled through the duty/stand-by arrangement of the compressor packages, redundancy in control valves, bypass of the recombiner and recombiner cooler, and delay bed isolation.

An outline maintenance plan for the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] is still to be developed.

## 11.3.9 Radiological Aspects

Minimisation of normal operation and maintenance doses to ALARP is one of the key design criteria in the systems engineering design decision process, see Section 11.3.12.

Opportunities to reduce radiological exposures during normal operation and maintenance have been considered within the design at PCD, such as physical segregation and shielding between the delay beds that are likely to have high dose rates, and redundancy and dose monitoring in the HVAC System [KL]

## 11.3.10 Preliminary Substantiation

Verification activities to substantiate safety categorised functional requirements and non-functional system requirements for the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] are still to be determined.

## 11.3.11 Installation & Commissioning

An outline installation and commissioning plan for the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] is still to be developed. The overall strategy for the RR SMR commissioning programme is presented in E3S Case Chapter 14: Plant Construction & Commissioning, Reference [19].

## 11.3.12 ALARP in Design Development

The design of the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] is being developed in accordance with the systems engineering design process, which includes alignment to RGP & OPEX, design to codes and standards according to the safety classification (to be confirmed), and a systematic optioneering process with down-selection of design options based on assessment against relevant safety criteria (as described in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [13]).

Processing and Treatment System for Gaseous Radioactive Effluent [KPL] design decisions made with respect to ensuring overall risks are reduced to ALARP include:

1. Use of delay beds over decay storage tanks for abatement of active gases, given it is based on well-established techniques and RGP, and offers advantages of a more passive design with simplified operation and lower risk of erroneous discharge. It is not expected that there will be an accumulation of activity on the delay beds, and therefore, the activated charcoal media is anticipated to be LLW at the end of life.

More detailed information on design decisions is presented in the System Outline Description, Reference [21]. Design decisions are also reviewed against criteria for BAT to reach an optimised position. The BAT aspects of design decisions for the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] are presented in E3S Case Chapter 27: Demonstration of BAT, Reference [20].

### 11.3.13 Ongoing Design Development

The RR SMR design definition is currently in development as described in Section 11.0.2. Development of the Processing and Treatment System for Gaseous Radioactive Effluent [KPL] will be informed by safety categorised functional requirements and non-functional system requirements placed onto the design as the safety analysis is developed.

This includes requirements that are informed by the wider internal hazard management strategy for hydrogen flammability and explosion, with hydrogen management in the gaseous effluent stream anticipated to include aspects of recombination, nitrogen purging, positive pressure, leak tightness, hydrogen detection and ventilation.

The method for tritium management is also still to be determined in conjunction with the HVAC System [KL] and fuel pool design.

# 11.4 Systems for Management of Solid Radioactive Waste

## 11.4.1 System & Equipment Functions

The primary function of the Solid Waste Treatment System [KM] is to collect, treat and package radioactive solid waste to be suitable for storage or dispatch. It collects, processes, stores, and dispatches LLW and ILW (HLW will be handled via the fuel route). The system supports delivery of the FSF of CoRM.

## 11.4.2 Safety Design Bases

Safety Functional Requirements

At PCD, safety categorised functional requirements and associated non-functional performance requirements for the Solid Waste Treatment System [KM] based on the HLSFs they deliver are still to be developed.

Non-Functional System Requirements

At PCD, non-functional system requirements for the Solid Waste Treatment System [KM] are still to be developed.

A full set of Non-Functional System Requirements are in development based on the E3S Principles, which will be systematically applied to each SSC as part of the systems engineering process.

Safety Classification

At PCD, the safety categorisation and classification for the Solid Waste Treatment System [KM], is still to be developed.

The seismic classification of SSCs is still to be assigned in accordance with methodology outlined in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [13].

## 11.4.3 Description

The Solid Waste Treatment System [KM] system collects, immobilises, stores and dispatches LLW and ILW waste, including evaporator concentrates, resins, filters, and backwash filter solids slurry, arising from waste generating systems such as CVCS [KB], Fuel Pool Purification System [FAL] and the Processing & Treatment System for Liquid Radioactive Effluent [KNF].

The Solid Waste Treatment System [KM] will also process dry radioactive waste from the Reactor Island [R01] and the rest of the plant and any miscellaneous wet wastes (such as sludges) which arise from the plant.

The baseline key performance and design parameters are presented in Table 11.4-1.

**Table 11.4-1: Key System Design and Performance Parameters for [KM]**

| Parameter | Value | Notes |
|---|---|---|
| Processing Flow Rate | **{REDACTED FOR PUBLICATION}** | Subject to further design of upstream systems and selection of processing equipment |
| Design Temperature | **{REDACTED FOR PUBLICATION}** | Solid waste will be handled and contained at ambient temperatures. Limits set based on maximum waste temperature at point of arising |
| Design Pressure | **{REDACTED FOR PUBLICATION}** | Mostly low pressure processes and ambient conditions |
| Operating Temperature | **{REDACTED FOR PUBLICATION}** | Solid waste will be handled and contained at ambient conditions |
| Operating Pressure | **{REDACTED FOR PUBLICATION}** | |

The Solid Waste Treatment System [KM] comprises the:

1. Processing and Treatment System for Solid Radioactive Waste [KMA], containing;

   a. Processing and Dispatch System for LLW [KMA10], including a compactor, drum scanner and fume hood for segregation of waste; a transportable cementation facility is proposed for waste immobilisation into waste containers suitable for disposal (e.g., third-height International Organization for Standardisation (ISO) Containers)

   b. Processing and Treatment System for ILW [KMA20], including ILW cementation equipment within a hot cell

2. Storage System for Solid Radioactive Waste [KME], containing;

   a. Temporary storage for LLW [KME10]

   b. Temporary storage for ILW [KME20], with transfer pumps to processing system and connection to sampling systems

   c. ILW store [KME30] for long-term storage of ILW after conditioning

The design of each sub-system is summarised in the following sections based on the System Outline Description, Reference [22].

### *Temporary storage for LLW [KME10]*

Dry solid LLW is collected and temporarily stored prior to transfer to the Processing and Dispatch System for LLW [KMA10]. Typical waste items include filters from the HVAC system [KL], RO membranes from the Processing and Treatment System for Liquid Radioactive Effluent [KNF], backwash filters from the Coolant Purification System [KBE], Fuel Pool Purification System [FAL] and the Processing and Treatment System for Liquid Radioactive Effluent [KNF], and dry active wastes from routine maintenance operations.

Dry wastes which are LLW at generation are segregated at source, collected, and packaged into waste packages for supply chain treatment and/or disposal.

### *Temporary storage for ILW [KME20]*

The Temporary Storage System for ILW [KME20] contains three distinct storage tank groups operating at atmospheric pressure: two concentrates storage tanks, three resins storage tanks, and two filter solids (sludge) tanks. All tanks have provisions for sampling and recirculation lines for waste characterisation, and each set of tanks is expected to include one transfer pump (still in development). Each tank group is summarised below, with further details provided in the System Outline Description, Reference [22].

Most wet solid waste generated by RR SMR is anticipated to be ILW, though some may be boundary ILW/LLW, such as evaporator concentrates and resins. Boundary ILW/LLW resins and concentrates will be stored in boundary resin and concentrate tanks respectively and allowed to decay in the Temporary Storage for ILW [KME20] before treatment and disposal as LLW via the Processing and Dispatch System for LLW [KMA10]. The activity concentration of concentrates shall be limited by a product specification for the evaporator, noting this value is still to be confirmed.

Whilst expected to be minimal, some dry ILW may be generated in RR SMR, in which case it will likely be transferred to the Processing and Dispatch System for LLW [KMA10] (if boundary ILW/LLW) or in the Processing & Treatment System for ILW [KMA20] (if the waste remains ILW) for temporary storage or transfer to the ILW Store [KME30].

Concentrates Storage Tanks

The two concentrates storage tanks collect the batches of concentrates that are drained from the evaporator when one of the bottom product specification limits has been met. The total required concentrate volume is **{REDACTED FOR PUBLICATION}** per tank to give a standard volume for concentrates tanks.

Evaporator concentrates will be transferred via gravity from the evaporator to the storage tank, including any particulate matter present. No additional water is planned to be added for transfer, though pipes will require flushing after every transfer. Any additional water will be sent directly to the Collection and Drainage System [KTA].

A recirculation line allows for mixing of tank contents to ensure a representative sample is taken. Jet mixing ejectors at the bottom of the tanks are proposed to minimise moving parts. The bottom of the tanks will be fitted with a draw-off sump, with the tank floor sloping to a low point where particulate material can collect. Any accumulated particulate will be transferred via the suction line, therefore reducing accumulation of tank particulate and sludges. Tanks will be connected to the HVAC system [KL] to remove aerosol radionuclides and any hydrogen hazards.

Resins Storage Tanks

ILW resin waste (as a slurry) is collected in the tanks from the CVCS [KB] and Fuel Pool Purification System [FAL]. There are three tanks which are identical and sized at **{REDACTED FOR PUBLICATION}** per tank, with one tank designated to preferentially collect ILW and two tanks to collect ILW/LLW boundary waste. It is expected that each tank will provide sufficient storage for 6 years (i.e., 4 cycles of 1.5 years).

Resins arise as a mixed resin/water stream which is either gravity drained or sluiced from the ion exchange beds to the storage tanks. Both transfer options will require excess water to be removed from the tank after the transfer. Mixing will be required periodically to prevent aggregation during storage. This can be achieved via strainers and air sparging with the use of water injection, as well as using the recirculation pump. Tanks will be connected to the HVAC system [KL] to minimise contamination spread and provide abatement of airborne activity.

The tanks will be shielded, given the potential high activity of the resins. The level of shielding required to minimise dose rates is still in development. The tanks will contain a strainer with a weir at the top (to allow or excess water drain off) and a strainer at the bottom of the tank to avoid resin deposition.

Filter Solids Storage Tanks

Suspended filter solids slurry will arise from backwashed filters in CVCS [KB], Fuel Pool Purification System [FAL] and the Treatment System for Liquid Radioactive Effluent [KNF]. The filter solids will be backwashed off the filters **{REDACTED FOR PUBLICATION}**, reducing the activity of the filter units from ILW to LLW. The resulting backwashed slurry is a dilute suspension of filter solids expected to remain ILW for the duration of the lifecycle of the plant.

The filter backwash tanks are in a duty-standby configuration, with each tank able to store **{REDACTED FOR PUBLICATION}** cycles' worth of retained filter solids and also have capacity for **{REDACTED FOR PUBLICATION}** filter's worth of backwashing slurry (i.e. prior to settling and decantation). The total volume of the tanks is expected to be **{REDACTED FOR PUBLICATION}**. Mixing will be required periodically to prevent aggregation during storage, achieved through recirculation of the tank contents.

### *ILW Store [KME30]*

The ILW Store [KME30] is a dedicated store designed to maintain the condition of ILW waste until their transport to the GDF, or until their activity has been sufficiently reduced through decay storage, for their disposal as LLW waste.

It contains immobilised wet solid wastes (resins, concentrates and filter solids) produced on site within their respective waste packages. The occasional dry solid ILW item in a suitable container may also be stored here. In addition to the storage area, it will include a receipt/export area, monitoring facilities and maintenance provisions. Access to the building will be determined as part of store design.

#### *Processing & Dispatch System for LLW [KMA10]*

The Processing & Dispatch System for LLW [KMA10] serves as a packing and dispatch facility for the dry LLW collected in the Temporary Storage for LLW [KME10]. It will comprise of Commercial-Off-The-Shelf (COTS) equipment that will be used to size reduce, characterise, and package a variety of dry LLW wastes into suitable packages for disposal. Equipment will include a compactor, fume cupboard, large and small article monitors, forklift, and waste buffer storage area.

The choice of waste package will be determined by the waste destination, which is either dispatch for supply chain treatment or directly for disposal and may be 200l drums in half or third-height ISO containers.

The system will also immobilise wet LLW solid waste including decayed resins and concentrates and any miscellaneous sludge arisings. It will comprise a set of modular equipment brought into the waste handling and campaign area, including batching vessel, powder hopper, mixer, agitation vessel and third-height ISO containers. Equipment will be used to create a solidified waste package for the wet LLW solid waste suitable for supply chain treatment or disposal.

#### *Processing & Treatment System for ILW [KMA20]*

The Processing & Dispatch System for ILW [KMA20] serves as a processing and dispatch facility for the wet ILW collected in the Temporary Storage for ILW [KME20]. The waste is packaged in a compliant container (e.g. in a $3m^3$ box or 500l drum) within which it is grouted prior to transfer to the ILW Store [KME30]. Grouting is expected to be undertaken via a mobile or turnkey processing equipment.

Minimal dry ILW is expected to be generated by RR SMR, given the design utilises backwashable filters over cartridge filters. However, the potential exists for activated components and other miscellaneous items to be ILW that can be decayed or decontaminated to LLW for disposal. As such, any dry ILW waste streams will be emplaced in suitable waste containers (such as a $3m^3$ box or 500l drum) and will be stored in the ILW Store [KME30].

### 11.4.4 Materials

Materials for the Solid Waste Treatment System [KM] will be selected to minimise risks associated with operator dose, corrosion, and decommissioning.

The description and justification of materials used for classified SSCs are presented in E3S Case Chapter 23: Structural Integrity, Reference [15].

### 11.4.5 Interfaces

The Solid Waste Treatment System [KM] functional and physical interfaces are described above, including internal system interfaces and key interfaces with the CVCS [KB], Fuel Pool Purification System [FAL], Treatment System for Liquid Radioactive Effluent [KNF], HVAC System [KL], and Sampling System [KU]. All interfaces are identified and managed within DOORS, including flow down of functional requirements.

### 11.4.6 System & Equipment Operation

The Power Station Operating Philosophy, Reference [16] provides the overarching information on how the plant and operator maintain control of key functions across the six defined operating modes, including the operating principles, required actions, means for transitioning between the operating modes, and relevant safety systems for each mode. This is summarised in E3S Case Chapter 13: Conduct of Operations, Reference [17].

The Temporary Storage for ILW [KME20] operations are batch-based, therefore the system will be aligned through manual selection of system configurations. Transfers are only expected during normal operations.

A concentrates batch transfer into the tanks is carried out when the evaporator reaches one of its specification limits, the frequency of which depends on the composition of the effluent to be treated; the order of one transfer per cycle is expected. Resins batch transfers and filter solids batch transfers are also expected once per cycle.

Resins and filter solids are expected to be transferred every six years from the Temporary Storage for ILW [KME20] to the Processing & Dispatch System for ILW [KMA20]. Concentrates which are confirmed at LLW levels can be routed to the Processing & Dispatch System for LLW [KMA10] for immobilisation.

### 11.4.7 Instrumentation & Control

The Reactor C&I System [JY] is required to provide control of functions performed by Temporary Storage for ILW [KME20]. C&I functions for other Solid Waste Treatment System [KM] sub-systems are still to be defined in conjunction with suppliers.

At PCD, it is expected there will be an ILW control room in addition to the MCR, with the ILW control room controlling hot cell operations in the Processing & Dispatch System for ILW [KMA20] and tank mixing and transfers from the tanks in the Temporary Storage for ILW [KME20]. However, the transfer of resins, concentrates, and filter solids into the tanks will be controlled from the MCR.

The Reactor C&I System [JY] will provide control functions for alignment of tank and pump configurations in the Temporary Storage for ILW [KME20], as well as automatic trips for pumps and valves for fail-safe shutdown and equipment protection (including high-level trips on tanks and low flow trips on pumps).

The Reactor C&I System [JY] will also monitor a range of key system parameters and provide indication of these to the operator in the control room and in the emergency control centre. It will also provide alarms to indicate that key system parameters are outside of the defined performance bands and/or safety limits. The envisaged requirements for monitoring, indication, alarms, and warnings are specified in the System Outline Description, Reference [22].

The allocation of safety categorised functional requirements to the Reactor C&I System [JY] will be presented in the C&I Engineering Schedule, described further in E3S Case Chapter 7: Instrumentation & Control, Reference [18].

### 11.4.8 Examination, Maintenance, Inspection & Testing

An outline maintenance plan for the Solid Waste Treatment System [KM] is still to be developed.

### 11.4.9 Radiological Aspects

Minimisation of normal operation and maintenance doses to ALARP is one of the key design criteria in the systems engineering design decision process, see Section 11.4.12.

Given the high activity of resins and filter solids expected in the storage tanks in Temporary Storage for ILW [KME20], waste storage tanks are being designed to be walled in and shielded such that person access to the tanks is not possible. Design features to minimise the potential for settling and blockages are also being implemented, such as wide sweeping bends and full-bore pipes, as well as design to prevent leaks, with bunds beneath each tank providing a form of secondary containment. The tanks will also be connected to the active HVAC System [KL] to minimise the risks associated with airborne activity. The Processing & Dispatch System for ILW [KMA20] cement processing will also be undertaken in a shielded cell. Shielding requirements for LLW handling and cementation have yet to be confirmed, with options including use of temporary local shielding when required.

The Temporary Storage for ILW [KME20] is anticipated to be a shielded facility based on the expected use of unshielded drums for wet solid waste cementation.

### 11.4.10 Preliminary Substantiation

Verification activities to substantiate safety categorised functional requirements and non-functional system requirements for the Solid Waste Treatment System [KM] are still to be determined.

### 11.4.11 Installation & Commissioning

An outline installation and commissioning plan for the Solid Waste Treatment System [KM] is still to be developed. The overall strategy for the RR SMR commissioning programme is presented in E3S Case Chapter 14: Plant Construction & Commissioning, Reference [19].

### 11.4.12 ALARP in Design Development

The design of the Solid Waste Treatment System [KM] is being developed in accordance with the systems engineering design process, which includes alignment to RGP & OPEX, design to codes and standards according to the safety classification (to be confirmed), and a systematic optioneering process with down-selection of design options based on assessment against relevant safety criteria (as described in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [13]).

Solid Waste Treatment System [KM] design decisions made with respect to ensuring overall risks are reduced to ALARP include:

1. A modular grout plant with waste loading in a shielded hot cell has been selected for the baseline design of the Solid Waste Treatment System [KM] to encapsulate solid wet ILW. This was selected over options such as a transportable modular grout plant with waste

loading inside the modular plant, as it offers increased operator protection against exposure to high dose rates, whilst removing requirements for compliance with road transport limits and constraints.

More detailed information on design decisions is presented in the System Outline Description, Reference [22]. Design decisions are also reviewed against criteria for BAT to reach an optimised position. The BAT aspects of design decisions for the Solid Waste Treatment System [KM] are presented in E3S Case Chapter 27: Demonstration of BAT, Reference [20].

### 11.4.13 Ongoing Design Development

The RR SMR design definition is currently in development as described in Section 11.0.2. Development of the Solid Waste Treatment System [KM] will be informed by safety categorised functional requirements and non-functional system requirements placed onto the design as the safety analysis is developed.

Effluent characterisation and source term modelling is to be undertaken to determine activity levels, validate the suitability of decay storage of wastes, and determine the volumes of wastes.

Dose assessments of the systems are also to be undertaken to determine the shielding requirements for storage tanks, implementation of further design features to minimise resin entrapment and blockages, and to inform operational and access requirements.

All further work items at PCD are specified in the System Outline Description, Reference [22].

# 11.5 Reactor Island Collection & Drainage Systems

## 11.5.1 System & Equipment Functions

The primary function of the Reactor Island Collection and Drainage System [KTA] is to collect effluents from across the Reactor Island [R01] and transfer the effluents to the appropriate system for treatment. The system supports delivery of the FSF of CoRM.

## 11.5.2 Safety Design Bases

Safety Functional Requirements

At PCD, safety categorised functional requirements and associated Non-Functional Performance Requirements for the Reactor Island Collection and Drainage System [KTA] based on the HLSFs they deliver are still to be developed.

Non-Functional System Requirements

At PCD, non-functional system requirements for the Reactor Island Collection and Drainage System [KTA] are still to be developed.

A full set of Non-Functional System Requirements are in development based on the E3S Principles, which will be systematically applied to each SSC as part of the systems engineering process.

Safety Classification

At PCD, the safety categorisation and classification for the Reactor Island Collection and Drainage System [KTA], is still to be developed.

The seismic classification of SSCs is still to be assigned in accordance with methodology outlined in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [13].

## 11.5.3 Description

The Reactor Island Collection and Drainage System [KTA] collects liquid radioactive effluents in tanks and sumps and transfers them for collection and treatment in the Processing & Treatment System for Liquid Radioactive Effluent [KNF] (or the Wastewater Drainage System [GM] for non-active effluents). The system manages both primary and spent liquid effluent from across the Reactor Island [R01] and segregates their collection and transfer route based on their characterisation (expected levels of radiological and chemical contamination).

The baseline key performance and design parameters are presented in 11.5-1.

**Table 11.5-1: Key System Design and Performance Parameters for [KTA]**

| Parameter | Value |
|---|---|
| System Flow Rate | **{REDACTED FOR PUBLICATION}** |
| Design Temperature | **{REDACTED FOR PUBLICATION}** |
| Design Pressure | **{REDACTED FOR PUBLICATION}** |
| Operating Temperature | **{REDACTED FOR PUBLICATION}** |
| Operating Pressure | **{REDACTED FOR PUBLICATION}** |

The Reactor Island Collection and Drainage System [KTA] comprises:

1. Reactor Coolant Drain Tank [KTA10], which collects, cools and discharges primary liquid effluent from the Reactor Coolant Pressurising System [JEF] steam bleed and Reactor Pressure Vessel (RPV) [JAA] seal leakage. It comprises the Reactor Coolant Drains Tank (RCDT), heat exchanger and a transfer pump. As effluents from primary coolant contain hydrogen and volatile fission products, a nitrogen blanket is required

2. Process Drains Tank [KTA20], which collects and discharges process and floor drain effluents from equipment drainage for maintenance, testing, safety relief blowdown etc. as well as the module floor drains. It comprises local intermediary storage tanks, pipework to collect from the module-based drain pans (via gravity), and a transfer pump. Process drains are combined with the active floor drains to minimise complexity given that the expected effluent characteristics are similar

3. Chemical Drains Tank [KTA30], which collects and discharges chemical drain effluents, including reactor coolant sampling effluents, resin de-watering, and filter backwash water. It comprises local intermediary storage tanks, pipework, and a transfer pump. Higher levels of contaminants are expected than process drains, resulting in the segregation between these liquid waste streams as they will require different treatment processes and

4. Non-Active Floor Drains [KTA40], which collects non-active drain effluents and discharges them to the Wastewater Drainage System [GM]. Discharges will be sampled prior to discharge, with effluent not suitable for discharge rerouted to the Processing & Treatment System for Liquid Radioactive Effluent [KNF]

A standardised drainage collection and transfer arrangement is to be applied (with details to be determined on a case-by-case basis), including:

1. Collection within a stainless-steel tank, with level measurement for automatic transfer to the Processing & Treatment System for Liquid Radioactive Effluent [KNF] upon reaching a set level (or by manual initiation). Pump type and location is still to be determined

2. Drainage pipework will be routed through risers, transferring drains from equipment down to the lower levels. Flexible hose connections to drainage manifolds via temporary connections or gullies are expected for some maintenance operations. Vacuum breakers in the manifolds may be required in some cases to prevent siphoning and

3. Effluents will be transferred via common headers with segregation only for different effluent categories. Pipework is expected to penetrate containment and the hazard shield as necessary.

The drainage system is in all buildings of the Reactor Island [R01], with the drainage tanks to be placed at the lowest points of the buildings to minimise the complexity by allowing systems to drain via gravity. Table 11.5-2 summarises the assumed collection points within Reactor Island [R01] as defined at PCD, (noting these are subject to change as the layout design progresses).

**Table 11.5-2: Assumed Drainage Tanks in [KTA]**

| Location | Collection points |
|---|---|
| Containment | 1 x RCDT |
| | 1 x Process & floor drain tank |
| Annulus | 2 x Process & floor drain tanks |
| | 1 x Non-active drain tank |
| Northern auxiliary building | 2 x Process & floor drain tanks |
| | 1 x Non-active drain tank |
| Access building | 2 x Process & floor drain tanks |
| | 1 x Non-active drain tank |
| Fuelling building | 2 x Process & floor drain tanks |
| Southern auxiliary building | 2 x Chemical drain tanks |
| | 2 x Process & floor drain tanks |
| Waste processing building | 2 x Chemical drain tanks |
| | 2 x Non-active drain tanks |

Further details of each sub-system is provided in the System Outline Description, Reference [23].

## 11.5.4 Materials

Materials for the Reactor Island Collection and Drainage System [KTA] will be selected to minimise risks associated with operator dose, corrosion, and decommissioning. At PCD, stainless steel is selected for the design of components in contact with radioactive gaseous effluent.

The description and justification of materials used for classified SSCs are presented in E3S Case Chapter 23: Structural Integrity, Reference [15].

## 11.5.5 Interfaces

The Reactor Island Collection and Drainage System [KTA] functional and physical interfaces are described above, including key interfaces for receiving effluents across Reactor Island [R01], and interface with the Treatment System for Liquid Radioactive Effluent [KNF] and the

Wastewater Drainage System [GM] for discharge of effluents. All interfaces are identified and managed within DOORS, including flow down of functional requirements.

### 11.5.6 System & Equipment Operation

The Power Station Operating Philosophy, Reference [16] provides the overarching information on how the plant and operator maintain control of key functions across the six defined operating modes, including the operating principles, required actions, means for transitioning between the operating modes, and relevant safety systems for each mode. This is summarised in E3S Case Chapter 13: Conduct of Operations, Reference [17].

The Reactor Island Collection and Drainage System [KTA] is designed to function during all modes of operation (1 to 6B), collecting leaks and normal let-down activities. Most of the system operations are automatically actuated based on level and temperature measurement, except for operations of Non-Active Floor Drains [KTA40].

In summary, for all operating modes during normal operation:

1. Reactor Coolant Drain Tank (RCDT) [KTA10]; upon high temperature (55°C) in the RCDT, valves will be aligned to allow for the recirculation of the primary effluent, whereby the RCDT pump will recirculate the RCDT cooler back into the RCDT until the bulk temperature is reduced to 50°C. Upon 'high' level of the RCDT, the RCDT valves will be aligned to discharge and the RCDT will transfer the effluent until the tank reaches 'low' level, which switches off the discharge pump

2. Process Drains Tank [KTA20] and Chemical Drains Tank [KTA30]; upon 'high' level of the drainage tanks, the valves will be aligned to discharge and the tank will transfer the effluent until the tank reaches 'low' level, which switches off the discharge pump

3. Non-Active Floor Drains [KTA40]; upon 'high' level of the drainage tank or initiation by operators, the drainage tank will need to be sampled before transfer to the appropriate treatment system. The tank can be configured to recirculate the tank to ensure a homogenous sample can be taken. If the sampled activity is sufficiently low the valves will be aligned to discharge to the Wastewater System [GM], otherwise the tank will be aligned to discharge to the Treatment System for Liquid Radioactive Effluent [KNF] until the tank reaches 'low' level, which switches off the discharge pump. Storage capacity in the receiving systems will be confirmed prior to alignment of valves for discharge

Operations during faulted operations are to be developed.

### 11.5.7 Control & Instrumentation

The Reactor C&I System [JY] is required to provide control of functions performed by Reactor Island Collection and Drainage System [KTA], including alignment of valve and pump configurations for receiving effluents (in the RCDT), discharge of effluents, switch over between pumps, or recirculation to mix for sampling.

The Reactor C&I System [JY] will also monitor a range of key system parameters and provide indication of these to the operator in the control room and in the emergency control centre. It will also provide alarms to indicate that key system parameters are outside of the defined performance bands and/or safety limits. The envisaged requirements for monitoring, indication, alarms, and warnings are specified in the System Outline Description, Reference [23].

The allocation of safety categorised functional requirements to the Reactor C&I System [JY] will be presented in the C&I Engineering Schedule, described further in E3S Case Chapter 7: Instrumentation & Control, Reference [18].

### 11.5.8 Examination, Maintenance, Inspection & Testing

An outline maintenance plan for the Reactor Island Collection and Drainage System [KTA] is still to be developed.

### 11.5.9 Radiological Aspects

Minimisation of normal operation and maintenance doses to ALARP is one of the key design criteria in the systems engineering design decision process, see Section 11.5.12.

Several hazard identification studies have been undertaken during the development of the Reactor Island Collection and Drainage System [KTA] up to PCD, which have identified actions for the design to consider draining and rinsing features to minimise maintenance doses. This will be explored as the design of the systems is progressed.

### 11.5.10 Preliminary Substantiation

Verification activities to substantiate safety categorised functional requirements and non-functional system requirements for the Reactor Island Collection and Drainage System [KTA] are still to be determined.

### 11.5.11 Installation & Commissioning

An outline installation and commissioning plan for the Reactor Island Collection and Drainage System [KTA] is still to be developed. The overall strategy for the RR SMR commissioning programme is presented in E3S Case Chapter 14: Plant Construction & Commissioning, Reference [19].

### 11.5.12 ALARP in Design Development

The design of the Reactor Island Collection and Drainage System [KTA] is being developed in accordance with the systems engineering design process, which includes alignment to RGP & OPEX, design to codes and standards according to the safety classification (to be confirmed), and a systematic optioneering process with down-selection of design options based on assessment against relevant safety criteria (as described in E3S Case Chapter 3: E3S Objectives & Design Rules, Reference [13]).

Reactor Island Collection and Drainage System [KTA] design decisions made with respect to ensuring overall risks are reduced to ALARP include:

1. Drainage tanks are incorporated over embedded sumps. Whilst embedded sumps are standard practice for existing PWR designs, the use of drainage tanks prevents issues seen in previous designs associated with inspection and maintenance of equipment embedded

in concrete. The design is also consistent with RGP for avoiding wet washing, since tanks can be integrated into modules where leaks are captured and washing volumes can be limited to relatively small surface areas

2. Effluent segregation is generally considered RGP, which has been applied where there are different processing requirements, and only merged where there are no significant differences

More detailed information on design decisions is presented in the System Outline Description, Reference [23]. Design decisions are also reviewed against criteria for BAT to reach an optimised position. The BAT aspects of design decisions for the Reactor Island Collection and Drainage System [KTA] are presented in E3S Case Chapter 27: Demonstration of BAT, Reference [20].

### 11.5.13 Ongoing Design Development

The RR SMR design definition is currently in development as described in Section 11.0.2. Development of the Reactor Island Collection and Drainage System [KTA] will be informed by safety categorised functional requirements and Non-Functional System Requirements placed onto the design as the safety analysis is developed.

Furthermore, strategies to mitigate internal flooding in the design of the Reactor Island Collection and Drainage System [KTA] are still to be developed in conjunction with the internal hazards teams.

All further work items at PCD are specified in the System Outline Description, Reference [23].

# 11.6 Conclusions

## 11.6.1 Conclusions

Preliminary evidence is presented to support the overall chapter claim that 'The RR SMR systems for the handling, minimising, conditioning, storing, and disposing of radioactive waste, are designed and substantiated to achieve their functional and non-functional safety requirements, and reduce risks to As Low As Reasonably Practicable', which contributes to the overall E3S objective to protect people and the environment from harm, and the demonstration that risks are reduced ALARP.

The SSCs presented in this revision of the E3S Case include the Processing & Treatment System for Liquid Radioactive Effluent [KNF], Processing and Treatment System for Gaseous Radioactive Effluent [KPL], Solid Waste Treatment System [KM], and Reactor Island Collection and Drainage System [KTA].

For each SSC, the design definition presented describes how the SSC is being developed to reduce risks to ALARP, based on its maturity at the PCD design stage. SSCs excluded from this revision based on limited maturity, as listed in Appendix A, will be incorporated as their design is matured.

The full suite of evidence to underpin the claim will be developed in line with the CAE Route Map and reported in future revisions of the E3S Case, including derivation of safety categorised requirements from the safety analysis, a complete set of non-functional system requirements from the E3S design principles, further development of the SSC concept design to meet safety requirements, and ultimately substantiation of safety requirements.

## 11.6.2 Assumptions & Commitments on Future Dutyholder/ Licensee

None identified in this revision.

## 11.7 References

[1] RR SMR Report, SMR0004294/001, “E3S Case Chapter 1: Introduction,” March 2023.

[2] RR SMR Report, SMR0004630/001, “E3S Case Chapter 26: Radioactive Waste Management Arrangements,” March 2023.

[3] RR SMR Report, SMR0004486/001, “E3S Case Chapter 29: Quantification of Radioactive Effluent Discharges and Proposed Limits,” March 2023.

[4] RR SMR Report, SMR0002155/001, “E3S Case CAE Route Map,” March 2023.

[5] IAEA Safety Standards Series No. SSR-2/1 (Rev. 1), “Safety of Nuclear Power Plants: Design,” February 2016.

[6] IAEA Safety Standards, “Predisposal Management of Radioative Waste, GSR Part 5,” May 2009.

[7] ONR, “Safety Assessment Principles for Nuclear Facilities, 2014 Edition, Revision 1,” January 2020.

[8] Environment Agency, “Radioactive substances regulation (RSR): objective and principles - GOV.UK (www.gov.uk),” December 2021. [Online]. Available: https://www.gov.uk/government/publications/radioactive-substances-regulation-rsr-objective-and-principles.

[9] Environment Agency, “RSR generic developed principles: regulatory assessment - GOV.UK (www.gov.uk),” [Online]. Available: https://www.gov.uk/government/publications/rsr-generic-developed-principles-regulatory-assessment.

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[11] RR SMR Report, SMR0003023/001, “Reactor Codes and Standards,” October 2022.

[12] RR SMR Report, SMR0002131/002, “Integrated Waste Strategy,” October 2022.

[13] RR SMR Report, SMR0004589/001, “E3S Case Chapter 3: E3S Objectives & Design Rules,” March 2023.

[14] RR SMR Report, SMR0000631/001, “System Outline Description for the Processing & Treatment System for Liquid Radioactive Effluent [KNF],” May 2022.

[15] RR SMR Report, SMR0004363/001, “E3S Case Chapter 23: Structural Integrity,” March 2023.

[16] RR SMR Report, EDNS01000912618/001, “Power Station Operating Philosophy,” January 2021.

[17] RR SMR Report, SMR0004247/001, “E3S Case Chapter 13: Conduct of Operations,” March 2023.

[18] RR SMR Report, SMR0003929/001, “E3S Case Chapter 7: Instrumentation & Control,” March 2023.

[19] RR SMR Report, SMR0004289/001, “E3S Case Chapter 14: Plant Construction & Commissioning,” March 2023.

[20] RR SMR Report, SMR_TBC/001, “E3S Case Chapter 27: Demonstration of BAT,” March 2023.

[21] RR SMR Report, SMR0000746/001, “System Outline Description for the Processing & Treatment System for Gaseous Radioactive Effluent [KPL],” May 2022.

[22] RR SMR Report, SMR0001123/001, “System Outline Description for the Solid Radioactive Waste Processing System [KM],” September 2022.

[23] RR SMR Report, SMR0000632/001, “System Outline Description for the Reactor Island Collection and Drainage System,” May 2022.

# 11.8 Appendix A: CAE Route Map

## 11.8.1 Chapter 11 Route Map

A preliminary Claims decomposition from the overall Chapter 11 Claim is summarised in Table 11.8-1, including the Tier 2 Evidence underpinning the Claims at PCD (i.e., summarised in Revision 1 of this report) and further Tier 2 Evidence still to be developed.

**Table 11.8-1: CAE Route Map**

| **Level 1 Claims** | **Level 2 Claims** | **Level 3 Claims** | **Arguments** | **Evidence Summary within Chapter 11** | **Underpinning Tier 2 Evidence**<br>***at PCD** | **Underpinning Tier 2 Evidence**<br>***to be developed** |
|---|---|---|---|---|---|---|
| Safety Functional & Non-Functional System Requirements are derived and justified based on sound safety principles and methods | - | - | A comprehensive set of functional requirements are derived in the safety analysis (Fault Schedule), placed on Structures, Systems & Components based on functions to be delivered during Plant States | n/a | n/a | DOORS Processing & Treatment System for Liquid Radioactive Effluent [KNF] Requirements Module |
| | | | | n/a | n/a | DOORS Gaseous Radioactive Effluent [KPL] Requirements Module |

| Level 1 Claims | Level 2 Claims | Level 3 Claims | Arguments | Evidence Summary within Chapter 11 | Underpinning Tier 2 Evidence<br><br>**at PCD* | Underpinning Tier 2 Evidence<br><br>**to be developed* |
|---|---|---|---|---|---|---|
| | | | Design Basis Condition (DBC) DBC-1 to DBC-5<br><br>Non-functional requirements are derived from the E3S principles and applied to the architecture of SSCs in accordance with their classification | n/a | n/a | Solid Waste Treatment System [KM] Requirements Module |
| | | | | n/a | n/a | DOORS Reactor Island Collection and Drainage System [KTA] Requirements Module |
| Architecture is designed to achieve safety requirements, considering RGP & OPEX to | - | - | The preferred design solution has been developed following a structured systems engineering | Section 11.2 | Processing & Treatment System for Liquid Radioactive Effluent [KNF] System Description [14] | Processing & Treatment System for Liquid Radioactive Effluent [KNF] (revised) |

| **Level 1 Claims** | **Level 2 Claims** | **Level 3 Claims** | **Arguments** | **Evidence Summary within Chapter 11** | **Underpinning Tier 2 Evidence**<br><br>***at PCD** | **Underpinning Tier 2 Evidence**<br><br>***to be developed** |
|---|---|---|---|---|---|---|
| reduce risks to ALARP | | | approach with evaluation against safety criteria supporting the decision-making process | Section 11.3 | Processing and Treatment System for Gaseous Radioactive Effluent [KPL] System Description, Reference [21] | Processing and Treatment System for Gaseous Radioactive Effluent [KPL] System Description (revised) |
| | | | | Section 11.4 | Solid Waste Treatment System [KM] System Description, Reference [22] | Solid Waste Treatment System [KM] System Description (revised) |
| | | | | Section 11.5 | Reactor Island Collection and Drainage System [KTA] System Description, Reference [23] | Reactor Island Collection and Drainage System [KTA] System Description (revised) |

| **Level 1 Claims** | **Level 2 Claims** | **Level 3 Claims** | **Arguments** | **Evidence Summary within Chapter 11** | **Underpinning Tier 2 Evidence**<br><br>***at PCD** | **Underpinning Tier 2 Evidence**<br><br>***to be developed** |
|---|---|---|---|---|---|---|
| The design has been substantiated to achieve its safety requirements through the lifecycle | Safety requirements have been substantiated | | Verification activities to demonstrate safety requirements can be achieved have been developed based on sound engineering judgement and methods | n/a | n/a | To Be Confirmed (TBC) |
| | Safety requirements have been verified through manufacturing, construction, installation, and commissioning | - | Processes and controls are designed to verify safety requirements during manufacturing, construction, installation, and commissioning | n/a | n/a | Installation and Commissioning Plans for each SSC (TBC) |

| **Level 1 Claims** | **Level 2 Claims** | **Level 3 Claims** | **Arguments** | **Evidence Summary within Chapter 11** | **Underpinning Tier 2 Evidence**<br><br>***at PCD** | **Underpinning Tier 2 Evidence**<br><br>***to be developed** |
|---|---|---|---|---|---|---|
| | Design can deliver its safety requirements during its operational life | - | The design identifies and facilitates Examination, Maintenance, Inspection and Testing (EMIT) activities commensurate with its safety classification to demonstrate its status, availability, and integrity in line with the design intent | n/a | n/a | Maintenance Plans for each SSC (TBC) |

# 11.9 Appendix B: SSCs in Scope of Chapter 11

Table 11.9-1 lists those SSCs that are within the scope of Chapter 11, and the section of the report they are addressed.

**Table11.9-1: SSCs in Scope of PCSR**

| RDS-PP | SSC | Section in PCSR |
|---|---|---|
| KM | Solid radioactive waste processing systems | Covered by [KM_] Sections |
| KMA | Processing and treatment system for solid radioactive waste | Section 11.4 |
| KMA10 | Processing and dispatch system for low level waste | |
| KMA20 | Processing and treatment system for intermediate level waste | |
| KME | Storage system for solid radioactive waste | |
| KME10 | Temporary storage for low level waste | |
| KME20 | Temporary storage for intermediate level waste | |
| KME30 | Intermediate level waste store | |
| KN | Liquid radioactive effluent processing system | Covered by [KN_] Sections |
| KNF | Processing and treatment system for liquid radioactive effluent | Section 11.2 |
| KNF10 | Processing and treatment system for primary liquid effluent | |
| KNF20 | Processing and treatment system for spent liquid effluent | |
| KNF30 | Liquid effluent monitoring and discharge system | |
| KP | Gaseous radioactive effluent processing systems | Covered by [KP_] Sections |

| RDS-PP | SSC | Section in PCSR |
|---|---|---|
| KPL | Processing and treatment system for gaseous radioactive effluent | Section 11.3 |
| KT | Reactor Island collection and drainage system | Covered by [KT_] Sections |
| KTA | Collection and drainage systems for liquid media and vent systems in controlled and exclusion area | Section 11.5 |
| KTA10 | Reactor coolant drain tank | |
| KTA20 | Process drains tank | |
| KTA30 | Chemical drains tank | |
| KTA40 | Non-active floor drains | |

# 12 Acronyms and Abbreviations

| | |
|---|---|
| ALARP | As Low As Reasonably Practicable |
| ASME | American Society of Mechanical Engineers |
| BAT | Best Available Techniques |
| BS | British Standard |
| C&I | Control and Instrumentation |
| CAE | Claims, Arguments, Evidence |
| CoRM | Confinement of Radioactive Material |
| COT | Core Outlet Thermocouple |
| COTS | Commercial-Off-The-Shelf |
| CVCS | Chemistry and Volume and Control System |
| DBC | Design Basis Condition |
| DOORS | Dynamic Object-Orientated Requirements System |
| E3S | Environmental, Safety, Security and Safeguards |
| EA | Environment Agency |
| EMIT | Examination, Maintenance, Inspection and Testing |
| FSF | Fundamental Safety Function |
| GDF | Geological Disposal Facility |
| GER | Generic Environmental Report |
| GSR | Generic Security Report |
| HEPA | High Efficiency Particulate Air |
| HLSF | High-Level Safety Function |
| HLW | High-Level Waste |
| HR | High Reliability |
| HVAC | Heating, Ventilation and Air Conditioning |
| IAEA | International Atomic Energy Agency |

| | |
|---|---|
| ILW | Intermediate-Level Waste |
| ISO | International Organization for Standardisation |
| IEX | Ion Exchange |
| LLW | Low-Level Waste |
| LLWR | Low-Level Waste Repository |
| MCR | Main Control Room |
| NWS | Nuclear Waste Services |
| ONR | Office for Nuclear Regulation |
| OPEX | Operating Experience |
| PCD | Preliminary Concept Definition |
| PCSR | Pre-Construction Safety Report |
| PWR | Pressurised Water Reactor |
| RCA | Radiologically Controlled Area |
| RCDT | Reactor Coolant Drainage Tank |
| RD | Reference Design |
| RDS-PP | Reference Design System for Power Plants |
| RGP | Relevant Good Practice |
| RO | Reverse Osmosis |
| RPV | Reactor Pressure Vessel |
| RR SMR | Rolls-Royce Small Modular Reactor |
| RSR | Radioactive Substances Regulation |
| SF | Spent Fuel |
| SSC | System, Structure and Component |
| TBC | To Be Confirmed |
| VHR | Very High Reliability |