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4.1 ACRONYMS AND ABBREVIATIONS

The standard project glossary of terms, abbreviations, and plant systems is provided in Holtec International's document, SMR-300 Acronyms and Glossary of Terms [1]. The following additional definitions and abbreviations are shown in Table 1.

Table 1: Definitions and Acronyms Used in this chapter

Term	Definition
ABB	Auxiliary Boiler Building
AC	Alternating Current
ALARA	As Low As Reasonably Achievable
ALARP	As Low As Reasonably Practicable
ANS	American Nuclear Society
ANSI	American National Standards Institute
AR	Annular Reservoir
BAT	Best Available Techniques
BNG	Biodiversity Net Gain
BREEAM	Buildings Research Establishment Environmental Assessment Methodology
BREF	BAT Reference documents
CCW	Component Cooling Water System
CEEQUAL	Civil Engineering Environmental Quality Assessment & Award Scheme
CES	Containment Enclosure Structure
CFC	Chlorofluorocarbons
CIA	Conventional Impact Assessment
CIRIA	Construction Industry Research and Information Association
CO_2	Carbon dioxide
CoC	Cycle of Concentration
COMAH	Control of Major Accident Hazards
COMAH15	Control of Major Accident Hazards Regulations 2015
COTS	Commercial Off-The-Shelf
CPO	Condensate Polisher System
CRS	Circulating Water System
CS	Containment Structure
CVC	Chemical and Volume Control System
DEFRA	Department for Environment, Food and Rural Affairs
DGB	Diesel Generator Building
DRP	Design Reference Point
DWS	Demineralised Water System
EA	Environment Agency
EIMT	Examination, Inspection, Maintenance and Testing
ELV	Emission Limit Value
EPR16	Environmental Permitting (England and Wales) Regulations 2016

Term	Definition
EPRI	Electric Power Research Institute
EQS	Environmental Quality Standards
EU	European Union
F-gases	Fluorinated greenhouse gases
FPS	Fire Protection System
GDA	Generic Design Assessment
GHG	Greenhouse Gases
GHGE	Greenhouse Gas Emissions
GRW	Gaseous Radwaste System
GWP	Global Warming Potential
H_2O_2	Hydrogen Peroxide
HEPA	High Efficiency Particulate Air
HFC	Hydrofluorocarbons
HSE	Health and Safety Executive
HVAC	Heating, Ventilation and Air Conditioning
IAEA	International Atomic Energy Agency
ICS	Industrial Cooling System
IED	Industrial Emissions Directive
LOOP	Loss of Off-site Power
LRW	Liquid Radwaste System
MCPD	Medium Combustion Plant Directive
MDCT	Mechanical Draft Cooling Towers
MFS	Main Feedwater System
MPC	Multi-Purpose Canisters
MW	Megawatt
MWe	Megawatt electrical
MWth	Megawatt thermal
NaOH	Sodium Hydroxide
NOx	Nitrogen Oxides
NPP	Nuclear Power Plant
NRW	Natural Resource Wales
ODS	Ozone-Depleting Substances
ONR	Office for Nuclear Regulation
OPEX	Operational Experience
P&ID	Piping & Instrumentation Diagram
PCH	Passive Containment Heat Removal System
PER	Preliminary Environmental Report
PFC	Perfluorocarbons
PSR	Preliminary Safety Report
PWS	Potable Water System
PWR	Pressurised Water Reactor

Term	Definition
RCS	Reactor Coolant System
RP	Requesting Party
RSR	Radioactive Substances Regulation
RWS	Raw Water System
SBO	Station Blackout
SBD	Standby Diesel Generators
SDG	Sustainable Development Goals
SDH	Secondary Decay Heat Removal System
SF_6	Sulphur Hexafluoride
SFSI	Spent Fuel Storage Installation
SGE	Steam Generator
SGB	Steam Generator Blowdown System
SMR	Small Modular Reactor
SO_2	Sulphur Dioxide
SRW	Solid Radwaste System
SSC	Structures, Systems and Components
SSEC	Safety, Security and Environmental Case
SuDS	Sustainable Drainage Systems
SWS	Service Water System
UK	United Kingdom
UKCP18	UK Climate Projections 2018
UK ETS	UK Emissions Trading Scheme
UN	United Nations
uPBT	Ubiquitous, Persistent, Bio-accumulative, Toxic
US	United States
WFD	Water Framework Directive
WWS	Waste Water System
WWT	Waste Water Treatment (within generic SMR-300)
WWTP	Waste Water Treatment Plant (municipal)

4.2 INTRODUCTION

This chapter provides information relating to key areas of conventional (non-radiological) environmental impact and sustainability for the generic Small Modular Reactor (SMR)-300 design.

This chapter's objectives, scope, interfaces and links with other Preliminary Environmental Report (PER) and Preliminary Safety Report (PSR) chapters are summarised in this section.

4.2.1 Purpose

The purpose of this Conventional Impact Assessment (CIA) chapter is to provide the Environment Agency (EA) and Natural Resources Wales (NRW) with the information required for a fundamental assessment of the conventional environmental impact of the generic Holtec SMR-300 design in a two-step Generic Design Assessment (GDA).

This chapter aims to demonstrate to stakeholders that the generic SMR-300 design has eliminated, minimised/mitigated conventional environmental impacts. It presents information which supports the Fundamental Purpose of the Safety, Security and Environmental Case (SSEC) [2] stated below:

> "*The generic 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.*"

Over GDA, Tier 2 documents were produced to support the aims of this chapter. The tier 2 documents have been summarised to underpin discussion across sub-chapters.

4.2.2 Scope

The scope of this chapter is based on the requirements outlined in the EA GDA Guidance for Requesting Parties (RP) [3] for a two-step GDA and the scope outlined in the GDA Scope document [4]. For a fundamental assessment of conventional environmental impacts, information is required on the following eight areas of conventional environmental impact and sustainability:

- Water use and abstraction.
- Discharges to surface water.
- Discharges to groundwater.
- Operation of installations (combustion plant and incinerators).
- Operation of medium combustion plant and specified generators.
- Control of Major Accident Hazards Regulations (COMAH).
- Fluorinated greenhouse gases (F-gases) and Ozone-Depleting Substances (ODS).
- Sustainability.

The GDA guidelines and regulatory context for each of the main aspects is also provided.

The scope of this chapter is bounded by the available data relating to the design, at the time of writing and the scope of the GDA [4]. In order to address gaps, appropriate data has been used from comparable PWR OPEX including the earlier Holtec SMR-160 design, and the current United States (US) SMR-300 design subject to licensing for construction at Palisades site (hereafter referred to as the "Holtec Palisades SMR-300").

The Holtec Palisades SMR-300 design is being developed for site-specific conditions at the Palisades site, therefore the generic SMR-300 design may differ in some aspects. However, Holtec Palisades SMR-300 represents a suitable starting point for making assumptions about the generic SMR-300 design, where required. Figure 1 illustrates the hierarchy of information used in this chapter. Data sources at the top of the hierarchy are the most beneficial and relevant to the PER. In descending order the information becomes less relevant, but remains useful.

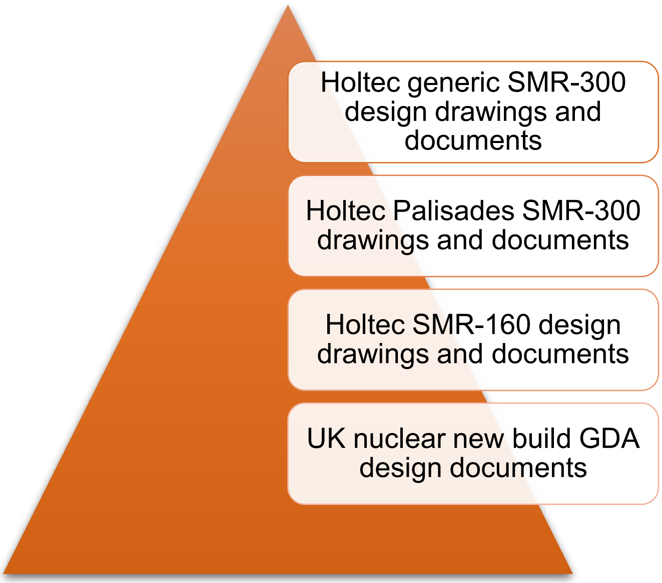

Figure 1: Hierarchy of information used to develop this chapter

Post-GDA actions and activities within the scope of CIA that have the intent of developing the SMR-300 design and methods of operation have been identified as future evidence and are listed in Table 8. Future evidence represents normal business for a nuclear new build development organisation or prospective operator of a UK SMR-300.

4.2.3 Chapter Structure

This chapter is structured as follows, to provide the information needed for a meaningful assessment of the generic SMR-300 in a clear and logical manner:

- Sub-chapter 4.1 lists the acronyms and abbreviations used in this chapter.
- Sub-chapter 4.2 introduces the purpose, scope, interfaces, and assumptions for this chapter.
- Sub-chapter 4.3 presents the regulatory context and the GDA requirements for each sub-topic within the CIA.
- Sub-chapter 4.4 describes the water use and abstraction in the generic SMR-300.
- Sub-chapter 4.5 describes the discharges to surface water in the generic SMR-300.
- Sub-chapter 4.6 discusses the discharges to groundwater in the generic SMR-300.
- Sub-chapter 4.7 describes the operation of installations, medium combustion plant (where applicable) and other specified generators (where applicable) in the generic SMR-300.

- Sub-chapter 4.8 describes the design considerations for COMAH in the generic SMR-300.
- Sub-chapter 4.9 describes the F-gases and ODS in the generic SMR-300.
- Sub-chapter 4.10 describes sustainability in the generic SMR-300.
- Sub-chapter 4.11 summarises the future evidence identified for PER Chapter 4
- Sub-chapter 4.12 contains an overall summary of the conventional environmental impacts of the generic SMR-300.

4.2.4 Interfaces with Other Chapters

Table 2 describes the interfaces and relationships between this chapter and other PER chapters for clarity, demonstrating the formation of a strategic environment case.

Table 2: Interfaces with Other Chapters of PER

Chapter Title	Interface
Holtec SMR GDA PER Chapter 1 Radioactive Waste Management Arrangements [5]	This chapter details the Liquid Radwaste System (LRW) that interfaces with the site outfall.
Holtec SMR GDA PER Chapter 5 Monitoring and Sampling [6]	This chapter covers systems designed for detecting external leakage or escape of radioactive and non-radioactive substances in the event of a fault.
Holtec SMR GDA PER Chapter 6 Approach and Application of the Demonstration of Best Available Techniques [7]	This chapter covers BAT which is an environmental optimisation concept that takes into account sustainability, and pollution prevention.
Holtec SMR GDA Chapter A2 General Design and Site Characteristics [8]	This chapter is linked to assumptions regarding the generic site in which the generic SMR-300 is situated, in particular that the site may be coastal or at a freshwater site.
Holtec SMR GDA PART A3 Claims, Arguments and Evidence	This chapter sets out the Claims, Arguments and Evidence structure for SSEC.
Holtec SMR GDA PART B Chapter 5 Reactor Supporting Facilities [9]	This chapter details the generic SMR-300 Heating, Ventilation, and Air Conditioning (HVAC) systems that use refrigerants.
Holtec SMR GDA PART B Chapter 9 Description of Operational Aspects and Conduct of Operations [10]	This chapter details the Examination, Inspection, Maintenance and Testing (EIMT) programme.
Holtec SMR GDA PART B 11 Environmental Protection [11]	This chapter provides a summary of each PER chapter and BAT claims.
Holtec SMR GDA PART B PSR Chapter 13 Radioactive Waste Management [12]	This chapter details the LRW that interfaces with the site outfall.
Holtec SMR GDA PART B 21 External Hazards [13]	This chapter details meteorological external hazards based on The UK Climate Projections 2018 to account for effects of reasonably foreseeable climate change over the lifetime of the facility.
Holtec SMR GDA PART B 23 Reactor Chemistry [14]	This chapter details the reactor chemistry regimes and systems.
Holtec SMR GDA PART B 24 Fuel Transport and Storage [15]	This chapter details sustainability considerations in the design of spent fuel storage systems.

4.2.5 Assumptions

Assumptions have been made to progress this chapter. A key assumption is that the generic SMR-300 will need to be adapted during the site-specific stage to account for environmental conditions encountered at site. Assumptions about the site have been discussed in more detail in PSR Part A Chapter 2 General Design and Site Characteristics [8].

Technical assumptions regarding the design relevant to the CIA are:

- The cooling system design is based on cooling tower technology, this does not preclude the design from opting for other cooling technologies during site-specific design.
- Water abstraction requirements are similar to those to the Holtec Palisades SMR-300 design.
- Potable water used in the generic SMR-300 will be supplied by municipal water supply.
- The concentration of chemicals stored for use in the generic SMR-300 is at 100% unless otherwise stated.
- The concentration of hydrazine stored for use in the generic SMR-300 is at 35%.
- The basis of design for the combustion plant present in the generic SMR-300 is the Holtec Palisades SMR-300 design.

4.3 REGULATORY CONTEXT

4.3.1 GDA Requirements

This sub-chapter describes the GDA requirements for each of the sub-topics considered within the CIA. These requirements are taken from the GDA Guidance for RPs [3], under the heading "information relating to other environmental regulations" in the "Information required for environment case submission" section.

4.3.1.1 GDA Requirements for Water Use and Abstraction

The guidance for "Water Use and Abstraction" [3] states:

> For water use and abstraction, the RP must provide details and estimates of:
>
> - Freshwater requirements for the design.
> - Cooling water requirements for the design relevant to the generic site.
>
> The RP should include its consideration of:
>
> - Seawater or river water abstraction.
> - Use of conventional cooling towers or hybrid cooling towers.
> - Abstraction inlet fish deterrent schemes.
> - Fish return systems.

Where available, the above information is provided for both a coastal and a freshwater generic site, using the assumptions for these sites discussed in PSR Part A Chapter 2 [8].

4.3.1.2 GDA Requirements for Discharges to Surface Water

The guidance for "Discharges to Surface Water" [3] states:

> For discharges to surface water the RP must provide a description of how aqueous waste streams will arise, be managed, and disposed of throughout the facility's lifecycle, including:
>
> - Sources and quantities of contaminants (including disinfectant and biocides), highlighting any priority substances as specified in the Priority Substances Directive [16].
> - Identifying effluent and surface water runoff streams contributing to the overall discharge and how they are controlled.
> - Potential options and the associated environmental impact for the disposal of each individual effluent stream.
> - The means of control if unplanned radioactive (or other) contamination of the discharge is detected.
> - The options for beneficial use of the waste heat produced.
> - The environmental impact of thermal discharges.

4.3.1.3 GDA Requirements for Discharges to Groundwater

The GDA Guidance for RPs for “Discharges to Groundwater” [3] states:

> If there are planned discharges to groundwater, the RP must describe the nature and quantity of those discharges and provide an assessment of the impact on groundwater. We do not normally allow discharges to groundwater.
>
> The RP must describe how accidental discharges of radioactivity to land and groundwater will be prevented in the detailed information they provide about their radioactive waste management arrangements.

4.3.1.4 GDA Requirements for Operation of Installations and Combustion Plant

In the most recent version of the GDA Guidance for RPs [3], two sections relate to emissions to air from combustion plant. These sections state:

Operation of Installations (Combustion Plant and Incinerators)

> The RP must identify the combustion plant that is provided in their nuclear power plant design, for example standby generators or auxiliary boilers. If the aggregate rated thermal input of all combustion plant is greater than 50MW, they must provide a comparison of the proposed technology against the relevant guidance (European Commission Guidance on Large Combustion Plants [17]).
>
> If the aggregate rated thermal input of all combustion plant is greater than 20MW, they must describe how they will monitor greenhouse gas emissions.
>
> If the design includes an on-site incinerator with a capacity of 1 tonne or more per hour, they must provide a comparison of the proposed technology against our sector guidance (Incineration of Waste (EPR5.01): additional guidance [18]).

Operation of Medium Combustion Plant and Specified Generators

> The RP must identify the medium combustion plant that is provided in their nuclear power plant design, for example standby generators. If the aggregate rated thermal input of all medium combustion plant is more than or equal to 1MW and less than 50MW, they must provide a comparison of the proposed technology against the relevant guidance (European Commission, Medium Combustion Plant Directive [19]) and our sector guidance (Collection: Medium combustion plant and specified generator UK Government Regulations [20]).

4.3.1.5 GDA requirements for COMAH

The guidance for COMAH [3] states:

> The RP must identify whether they will store quantities of substances on site that are above the qualifying thresholds in COMAH15 (Control of Major Accident Hazards Regulations 2015 [21]).

The RP must describe the measures taken in the design to prevent a major accident to the environment if they exceed a COMAH threshold.

4.3.1.6 GDA Requirements for F-Gases and ODS

The GDA Guidance for RPs [3] states:

The RP must identify whether any equipment included in the design will contain Fluorinated Greenhouse Gases (F-gases) or Ozone-Depleting Substances (ODS) – as defined in the Fluorinated Greenhouse Gases Regulations 2015 [22] and Ozone Depleting Substances Regulations 2015 [23]. See our guidance on F-gases (UK Government, Bans on F gas in new products and equipment: current and future [24]).

If so, they must describe the measures taken in the design to prevent and minimise the leakage of such substances.

4.3.1.7 GDA Requirements for Sustainability

There are no specific requirements for sustainability, however the most recent version of the GDA Guidance for RPs [3] has been updated to indicate the importance of achieving sustainable development. The GDA Guidance for RPs [3] states:

The EA and NRW expect to see relevant sustainability considerations taken into account in the design of new nuclear power plants. These considerations may include:

- Carbon accounting.
- Climate change adaptation and resilience.
- Sustainable management of natural resources.
- Long term lifecycle impacts.
  Contribution to a circular economy.

We expect the RP to share their plans to develop the following information in preparation for the Step 2 assessment:

- Information on how sustainability is taken into account in decisions relating to the design. Our RSR principles support this objective and aim to ensure our regulation of radioactive substances activities contribute towards the achievement of sustainable development – these include principles relating to optimisation, BAT and lifetime planning for radioactive substances.

4.3.2 Regulatory Context for GDA Requirements

This section provides an overview of the key statutes and regulations which apply to each area of the CIA. How the regulations apply to the generic SMR-300 design is discussed in more detail in the following sub-chapters.

4.3.2.1 Regulatory Context for Water Use and Abstraction

The Water Resources Act [25] is the primary legislation providing the framework for managing water usage, abstraction, pollution, and flood defence. With reference to the Water Resources Act, Part II, Chapter II, any abstraction of water from a water supply, excluding the open sea, requires a licence where the abstraction is more than 20 cubic metres ($20m^3$) over a 24-hour period. A licence is also required for any impoundment activities, such as a dam or diversion of water supplies. This act gives power to relevant authorities to prosecute, by means of a fine, for any corporate body not complying with these requirements.

The Eels Regulations [26] contains provisions for recording and fishing of eels, the passage of eels in relation to new structures, and gives power to the appropriate agency to request construction of eel passes or suitable diversions/deterrents. The statutory instrument also contains provisions for penalties to be applied in the case of an offence committed with respect to these regulations. For the purposes of this chapter, provisions relating to eel passage obstructions and means for preventing ingress of eels are the most relevant. These regulations will generally apply wherever there is water abstraction in marine or freshwater environments, will stipulate the need for eel screens or other relevant conditions in the abstraction licence. The applicability of the Eels Regulations 2009 [26] will be considered in more detail during the site-specific stage.

The Salmon and Fisheries Act [27] is the main legislation covering the protection of fishing stocks and protected fish species (and other marine animals). The act also contains provisions related to fish passes and screens, similarly to the Eels Regulations [26].

In addition, the design and operation of the cooling system will give due consideration to all applicable BAT Reference (BREF) documents, including the European Union (EU) BREF document for Industrial Cooling Systems (ICS) [28]. The BREF ICS document [28] complies with regulatory requirements and recommends techniques that enhance energy efficiency, reduce water consumption, and mitigate negative ecological effects by optimising the cooling process.

4.3.2.2 Regulatory Context for Discharges to Surface Water

The Priority Substances Directive [16] is a key piece of legislation which applies to water discharges. This Directive contains a list of priority substances which have ubiquitous, persistent, bio-accumulative/toxic (uPBT) properties. Limits, or Environmental Quality Standards (EQS), for each of the priority substances are set in the Environmental Quality Standards Directive [29]. Although the United Kingdom (UK) is no longer in the EU, the Environmental Quality Standards Directive has effect through the UK Water Framework Directive (WFD) [30].

Where appropriate, systems that manage aqueous waste for discharge to surface water will give due consideration to all appliable European Commission BREF recommendations, including:

- Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector BREF document [31].
- Monitoring of Emissions to Air and Water from Industrial Emissions Directive (IED) Installations BREF document [32].
- Waste Treatment BREF document [33].

These documents offer practical guidance for monitoring water pollutions and both hazardous and non-hazardous waste treatment processes.

In addition to Priority Substances Directive, water discharges and trade effluent is regulated by the Environmental Permitting (England and Wales) Regulations 2016 (EPR16), as amended [34]. These regulations require operators to hold a permit for discharges of trade effluent to controlled waters (under normal operation).

Applicants for permits must supply the relevant data on discharge frequency, volume, and chemistry to the relevant local authority in which the discharge will take place. The Applicant also must undertake an assessment of the impact of these releases on the environment. Minimising thermal impact of discharges to water is regulated through the EPR16. A standard rules permit requires the applicant to ensure all discharges to surface water are below 25˚C and that the difference between the inlet and the outfall temperature is <8˚C (as per Standard Rules SR2010No2 – discharge to surface water: cooling water and heat exchangers [35]).

A site-specific SMR-300 may require a bespoke permit; however, the Standard Rules permits represent a baseline for the permitting requirements for the GDA of the generic SMR-300.

4.3.2.3 Regulatory Context for Discharges to Groundwater

As with discharges to surface water, discharges to groundwater are covered by the EPR16 [34]. Any discharge to groundwater which results in pollution of groundwater is an offence under these regulations, including intentional discharges and discharges from negligence. Exempt groundwater discharge activities under Schedule 3, Part 3 of the EPR16 [34] only apply in certain conditions and will depend on the specific site. The generic SMR-300 design will not be discharging to groundwater; however, for completeness, relevant guidance has been included here.

Consideration of relevant BREF guidance such as Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector [31], and Waste Treatment [33], industry standards applicable to prevention of pollution can ensure BAT measures are taken to protect groundwater from pollutants and mitigate any consequences of any accidental release.

BAT measures shall be undertaken when discharging to groundwater as per the Construction Industry Research and Information Association (CIRIA) guidance C736 [36] which supersedes CIRIA R164 to reflect the latest changes in legislation, design and practice. The technical advice focuses on preventing accidental groundwater pollution and spills of non-radioactive pollutants from industrial incidents. Additionally, the advice covers aspects of planning, design, and construction of containment systems.

4.3.2.4 Regulatory Context for Operation of Installations and Combustion Plant

Industrial combustion plant, including backup energy generation, and any incineration activities are subject to EPR16 [34]. These regulations implement the requirements of EU Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control), referred to more commonly as the IED [37].

Under these regulations, industrial combustion plant is required to have a permit if either of the following conditions apply:

- The site comprises a single combustion source with a rated thermal input of greater than or equal to (Megawatt thermal) 50MWth, or;
- The site comprises multiple combustion sources, which have an aggregated thermal input of greater than or equal to 50MWth and these are operated at the same time by the same operator.

For combustion plant that is less than $50MW_{th}$ but greater than $1MW_{th}$, the Medium Combustion Plant Directive (MCPD) [19] would apply and a permit obtained for combustion plant falling within this remit (medium combustion plant). Any new combustion plant will need to comply with Emission Limit Values (ELV) for specified pollutants, primarily sulphur dioxide (SO_2), nitrogen oxides (NO_x) and dust, see Annex II of the MCPD regulations [19]. The ELV for consideration will depend on the type, fuel material and technology of the combustion plant. Consideration of aggregation must be made for multiple combustion plants having a common stack.

Specified generators may need a permit depending on their technology. Generators specified for a defined nuclear safety role on a nuclear licenced site issued by the Office for Nuclear Regulation (ONR) are excluded from these permit regulations [38].

European Commission BREF documents can be consulted, including Monitoring of Emissions to Air and Water from IED Installations [32], and the Large Combustion Plants BREF document [17]. The Large Combustion Plants BREF document specifically addresses combustion plants over $50MW_{th}$ input and emphasises the importance of monitoring associated pollutants, but the principles outlined are applicable to smaller combustion plant as well.

The UK Emissions Trading Scheme (UK ETS) is the UK's "cap-and-trade" system for regulating and limiting greenhouse gas (GHG) emissions in the UK. It is put into effect by the Greenhouse Gas Emissions Trading Scheme Order 2020 [39]. The scheme encourages decarbonisation by capping how much carbon participants can emit, referred to as the emissions allowance. Any emissions over the cap may be traded with other participants, encouraging overall reduction of carbon emissions between participants. For combustion plant over $20MW_{th}$ operating in the UK it is necessary to obtain a Greenhouse Gas Emissions (GHGE) Permit under the GHGE Trading Scheme Order [39].

4.3.2.5 Regulatory Context for COMAH

Any facility storing priority substances on site are subject to COMAH Regulations 2015 [21]. These regulations require facility operators to prepare and retain a written major accident prevention policy. Such policies must be configured to ensure a high degree of protection of human health and the environment, from major accidents resulting from the misuse or accidental release of dangerous substances, listed in Schedule 1 of the COMAH Regulations [21].

The COMAH regulations [21] define two tiers of facility, namely lower and upper tier facilities. These relate to lower and upper thresholds of dangerous substances respectively. The exact measures to be taken by operators of COMAH facilities depend on the tier, and type of dangerous substance. Generally, operators of COMAH facilities must undertake all measures necessary to prevent a major accident and identify measures for mitigation in the event of any major accident should it occur.

4.3.2.6 Regulatory Context for F-gases ODS

The Fluorinated Greenhouse Gases Regulations 2015 [22] regulate the use of F-gases in the UK. These regulations implement the requirements of EU Regulation No. 517/2014 on F-gases [40].

These regulations aim to do the following when compared to 1990 levels:

a) reduce the use of non-CO_2 (carbon dioxide) GHGs, including F-gases, by 72-73% by 2030; and
b) reduce the use of non-CO_2 GHGs, including F-gases, by 70-78% by 2050.

This will be done through limiting the use of equipment containing such gases, take action on the use of hydrofluorocarbons (HFCs) in accordance with the Montreal Protocol [41], and encourage training and certifications for expertise in managing with F-gases, equipment using F-gases, and alternative technologies.

The EU regulations on F-gases [40] establishes rules on storage use and disposal of F-gases, limitations of introducing new products using specific F-gases to the market, and limits how F-gases may be used. The UK regulations [22] echo these stipulations with references to the EU regulations and giving power to the relevant authority (EA and NRW) to prosecute for offences under the regulations.

A list of all F-gases and their global warming potential can be found in the UK government guidance [22]. This guidance also outlines the UK governments commitments to reducing the use of HFCs by 79% by 2030. The tables in this guidance should be used by any facility using HFCs, perfluorocarbons (PFC)s or sulphur hexafluoride (SF_6).

The ODS Regulations 2015 [23] sets provisions for undertaking work related to specific ODS. These regulations set the need for identifying appropriately qualified people to recover, recycle, reclaim, or destroy controlled substances, and preventing and minimising the leakage of controlled substances. Schedule 2 of the ODS regulations identify specific tasks in handling equipment containing controlled substances.

4.3.2.7 Regulatory Context for Sustainability

Sustainability considerations include environmental impacts but may also include social and economic issues. The Sustainable Development Goals (SDGs) [42] developed by the United Nations (UN) outline several considerations for sustainability. These are not regulations however provide a framework to guide sustainability policies.

The Environment Act 1995 [43] states the duty of the EA to promote sustainable development in its operations, including protecting or enhancing the environment, taken as a whole:

"It shall be the principal aim of the Agency… in discharging its functions so to protect or enhance the environment, taken as a whole, as to make the contribution towards attaining the objective of achieving sustainable development."

Wales has specific legislative instruments which set provisions for sustainable development. In addition to the legislation already mentioned in this chapter, the Well-being of Future Generations (Wales) Act 2015 [44] sets seven well-being goals for public bodies undertaking development in Wales. The development is required to be 'sustainable development' and applies to a specific list of public bodies. There is potential for alterations to this Act in the future and therefore it is likely that sustainability will become a requirement at site-specific stage. The Environment (Wales) Act 2016 [45] embodies principles of sustainability through planning and management of natural resources for developments.

The International Atomic Energy Agency (IAEA) has published a document which outlines the key areas for improvement which could enhance sustainability in Nuclear Energy Systems [46], one of which is related to the accumulation of spent fuel that is creating a high-level radioactive waste for future generations to manage.

In November 2023, sustainability within nuclear was addressed at the International Conference on the Safety of Radioactive Waste Management, Decommissioning, Environmental Protection and Remediation [47]. This conference highlighted several key topics, including decarbonisation and climate change, resource sustainability and the relationship between safety and sustainable development, indicating that the importance of these topics is still high for the nuclear industry.

4.4 WATER USE AND ABSTRACTION

This sub-chapter describes aspects of the generic SMR-300 relevant to water use and abstraction, where the information is available and within GDA scope. During Step 2 an assessment of system functionality, connectivity and design was completed and presented in HI-2240918, Holtec SMR-300 Water Use, Abstraction and Discharges report [48], this sub-chapter summarises discussion from the report.

The connectivity of generic SMR-300 systems from abstraction to discharge is illustrated in (Figure 2). This flow diagram has been developed using information from the Holtec Palisades SMR-300 design, specifically its conceptual water balance drawing [49]. Holtec Palisades SMR-300 systems using or containing water informed the postulated system connectivity in the generic SMR-300 (Figure 2). This area of the design is under development and subject to change. Nonetheless, the information of the Holtec Palisades SMR-300 represents a good basis from which future design work may develop.

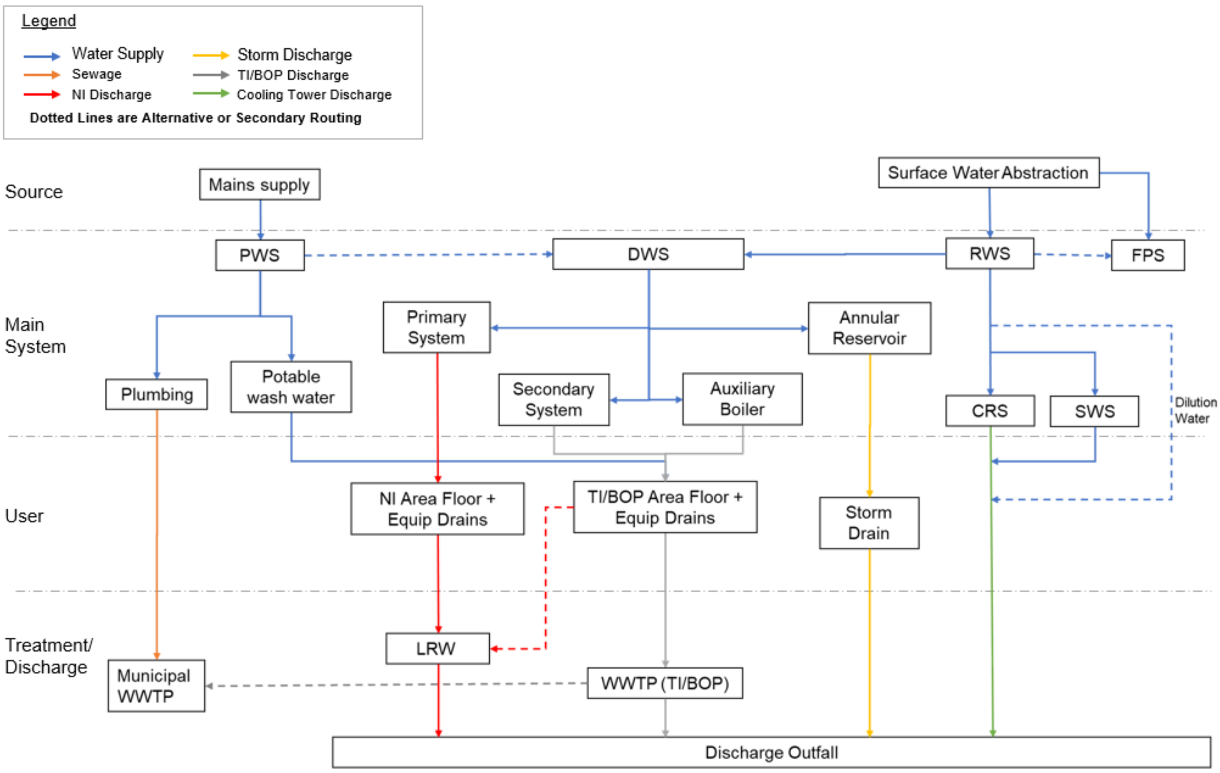

Figure 2: Simplified water use in the generic SMR-300 design (based on the conceptual water balance for the SMR-300 [49].

As shown in Figure 2, there are various SSC (Structures, Systems and Components) in the generic SMR-300 which are supplied by either surface or potable water sources. These are listed below:

- Raw Water System (RWS).
- Potable Water System (PWS).
- Demineralised Water System (DWS).

- Fire Protection System (FPS).
- Service Water System (SWS).
- Circulating Water System (CRS).

The overall functionality and connectivity of these systems is outlined in this section. System specification, including equipment sizing and precise water demand, is subject to development in later stages of design. Water demand of the generic SMR-300 will be met either by municipal water supply or by surface water abstraction.

The PWS will be supplied by an identified source of potable water. The PWS stores and transports potable water to welfare and wash water facilities. Potable water supply arrangements are to be confirmed at the site-specific stage. At this stage it is assumed that PWS will be supplied by municipal water supply.

The RWS and FPS will be supplied by an identified surface water source. The RWS distributes surface water to the Mechanical Draft Cooling Towers (MDCT), comprising the SWS and CRS. This system is out of scope for GDA, and alternative designs, such as using potable water source to supply the RWS or FPS, are not foreclosed at this stage.

In the concept design for the Holtec Palisades SMR-300, the RWS, and optionally the PWS, supplies the DWS. Water supplied to the DWS from the RWS will require additional pre-treatment, depending on the raw water quality (i.e. freshwater or seawater). For a coastal site this may include a desalination plant; however, the RWS for the generic SMR-300 is out of scope for this GDA and therefore design options are not foreclosed at this time. The need for pre-treatment and desalination plant is specific to the site location. In the scenario that the PWS is supplying the DWS, less pre-treatment will be required as the potable water supply will already meet a certain water quality standard. This is subject to site-specific supply constraints.

The DWS purifies water through removal of impurities and dissolved species and supplies demineralised water to a multitude of plant users, including the primary coolant circuit, secondary steam generating equipment and distribution points to enable flushing and decontamination of plant equipment or rinsing of wastes. The Position Paper on SMR-300 Plant Demineralized Water Treatment System Output Quality Considerations and Requirements outlines the specifications for demineralised water quality for use in the primary and secondary circuits [50]:

Table 3: Water Quality Requirements for Demineralised Water

Constituent (unit)	Effluent Limit
Sodium (ppb)	<0.1
Chloride (ppb)	<0.5
Sulphate (ppb)	<0.5
Silica (ppb)	<5.0
Total Organic Carbon (ppb)	<20
Conductivity (µS/cm @ 25˚C)	0.056
Dissolved Oxygen (ppb)	<5

4.4.1 Cooling Technology in the Generic SMR-300

For the purposes of this GDA, indirect cooling (in this case, MDCT) systems are employed as the principal cooling method in the generic SMR-300. As described in the SMR-300 Plant Overview report [51], for sites with an adequate water supply the MDCT option has low spatial configuration requirements. Other cooling technologies are not foreclosed at this stage. Indirect cooling systems can be operated with different cooling mediums (i.e. seawater or freshwater) depending on availability at a site-specific level. For example, depending on the sensitivities of the site (surface water scarcity or conservation designations e.g. Special Sites of Scientific Interest) it may be concluded that air-cooled condensing technology is determined to be best considering all factors.

Air-cooled condensers typically require more space due to their reliance on conduction of heat from specially designed fins having a large surface area. As ambient dry air flows over the fins, heat is transferred from the medium to atmosphere. In contrast, heat transfer in the MDCT systems is by a flow of air being drawn through steam which loses heat rapidly to atmosphere as it condenses. Therefore, air-cooled condensers require more space, while MDCT requires a reliable supply of water.

Indirect cooling mechanisms such as MDCT systems typically consume less water than direct (once-through) cooling systems, as the condensed steam can be recirculated following treatment. Air-cooled condensers require no water to provide a cooling capacity. The selected cooling technology is subject to options assessment at the site-specific stage (see Table 8: Future Evidence, CIA_01). This must demonstrate compliance of the cooling system's abstraction and discharges with local environmental constraints, and take into account the recommendations outlined in the EU ICS BREF note [28].

4.4.2 Water Abstraction Provisional Volumes and Sources

Water abstraction by the generic SMR-300 is estimated to be approximately [REDACTED] per hour. The water abstraction volume has been derived from the Holtec Palisades SMR-300 design and assumes that the PWS will be supplied by municipal water source, and the cooling technology is MDCT. The generic SMR-300 design does not preclude a site location, and both coastal (seawater) and inland (freshwater) sites can be considered.

In the case of the generic SMR-300 being located at a site with a freshwater supply, an abstraction licence from the appropriate agency will be required as early estimations of water abstraction rates exceed the legal limit of 20m^3/day. An abstraction licence would not be required for the abstraction of seawater at a coastal site. Plant water balance figures for all SMR-300 systems and therefore total plant water usage will be determined as part of site-specific stage (see Table 8: Future Evidence, CIA_02).

4.4.3 Water Intake Considerations

The intake (and corresponding outfall) design will be further developed once a site has been selected and detailed modelling can be conducted. The locations of the intake and outfall structures will be suitably distanced so that the intake does not abstract water recently discharged from the outfall. This prevents thermal recirculation from occurring i.e. interaction of the discharge plume with abstracted water, which can reduce plant operation efficiency.

Water demand can be optimised through application of BAT at design development and by taking account relevant BREF documents, such as the BREF document on ICS [28].

Design considerations associated with the protection of aquatic organisms during abstraction can be developed if needed using the output from site specific assessments. Protective measures for fish and other marine or freshwater biota may be required for abstraction or impoundment structures. These measures may include:

- Physical barriers, such as fish screens to minimise entrainment.
- Engineering constraints on intake velocity to prevent likelihood of fish impingement at intake screens.
- Physical deterrents, such as locating the inlet pipe away from specific habitats of interest and protected areas.
- Behavioural deterrents, such as light and sounds to deter fish and eels away from inlet.

The design will consider the requirements of the local water ecology and legal requirements as outlined in Section 4.3.1.1 above.

4.4.4 Water Use and Abstraction Summary

The main users of water in the generic SMR-300 have been identified. Water will be abstracted from local water supply and from surface water sources to the PWS, RWS and FPS, from which appropriate treatment applied for use in the connected systems throughout the generic SMR-300. Determining exact water demand is dependent upon further design development, based on the Holtec Palisades SMR-300 figures, that the generic SMR-300 will abstract [REDACTED] per hour. For candidate sites where the generic SMR-300 will be abstracting from a freshwater body, an abstraction licence will be required. For candidate sites where with generic SMR-300 is abstracting from the sea, an abstraction licence will not be required. Estuarine sites will require further assessment. For systems using a municipal water supply, agreement with the local water companies will need to be made. Applications for licences to abstract water and future agreements are a site-specific consideration

Environmental impact will be minimised through consideration of the requirements in the future abstraction licence, through the implementation of fish screens and other engineering constraints on the intake. Design of the intake structure will be developed when a site has been chosen to ensure a bespoke solution that takes account of site-specific factors.

The cooling technology for the generic SMR-300 is not foreclosed in this CIA chapter; however, for the purpose of conducting a meaningful assessment it has been assumed that MDCT technology will be utilised. This system advantageously uses less water than a once-through system, and primarily rejects thermal energy to air. Treatment of the MDCT blowdown effluent may also be re-used in the systems, assuming the treated blowdown effluent meets water quality requirements of the systems (see Section 4.5.2) for more information on this aspect of the generic SMR-300). Air-cooled condensing technology may be used in combination, or instead of MDCT technology, depending on constraints of the site (space and water use), and the generic SMR-300 does not foreclose options for cooling technology.

4.5 DISCHARGES TO SURFACE WATER

This sub-chapter describes the aspects of the generic SMR-300 which relate to discharges to surface water, within the GDA scope. Areas of the generic SMR-300 which fall outside the GDA scope, but have relevance to this sub-chapter will be discussed where applicable. At Step 2, a high-level assessment of discharges from the generic SMR-300 was conducted and the results are discussed in Water Use, Abstraction and Discharges report [48].

Figure 2 shows the main systems in the generic SMR-300 that use water and generate effluent for discharge at the plant's outfall. As discussed above, these systems have set water quality requirements for their effective functioning, and therefore chemicals are added to treat the water prior to its use. In this sub-chapter, a discussion of each of the systems and their discharges is provided. Water and thermal efficiency are discussed at the end of this sub-chapter.

4.5.1 Effluent Sources in the Generic SMR-300

Effluents are generated through normal operations and maintenance and can be categorised into process and non-process effluents. Process effluent is generated through operations of generic SMR-300 equipment to meet design requirements. The principal sources of process effluent from the generic SMR-300 are:

- MDCT systems – including blowdown from cooling towers, CRS and SWS.
- LRW (including primary circuit effluents).
- Secondary cooling systems.
- Annular Reservoir (AR).

Non-process effluents include those which do not arise from routine operations of generic SMR-300 equipment. The principal sources of non-process effluent streams are:

- Sewage effluent,
- Surface water runoff.
- Laundry waste water (if applicable).

4.5.2 Mechanical Draft Cooling Tower and Related Systems

The CRS and SWS are the principal interfacing systems with the MDCT in the generic SMR-300 design. The quality of water supplied to these systems will impact upon the performance of the MDCT. As shown in Figure 2, the SWS and CRS are supplied by the RWS. The quality of water must be controlled by chemical dosing to achieve optimal plant performance of the MDCT. The Cycle of Concentration (CoC) is defined as the ratio of water supply to blowdown rate in a cooling tower system. Based on Diablo Canyon PWR (Pressurised Water Reactor) Operational Experience (OPEX), CoC for seawater systems is between 1 and 1.5 and for freshwater systems it is between 2 and 5. Therefore the exact chemical composition of the coolant in these systems (and therefore the discharges from these systems) will be a site-specific consideration.

The generic SMR-300 will generate effluent as part of routine operation as per industry practice discussed in EA report, Chemical discharges from nuclear power stations: historical releases and implications for Best Available Techniques [52]. Blowdown from the cooling tower is essential to maintain water quality within the cooling circuit. Blowdown will typically contain biocides, scale inhibitors, polymer dispersants and corrosion inhibitors.

The Closed Cooling Water Chemistry Strategic Plan developed for Holtec Palisades SMR-300 provisionally indicates the biocide for the MDCT systems may be chlorine and/or sodium hypochlorite. Ethylene glycol and propylene glycol may be added to prevent freezing [53]. The specific selection of chemicals used in the MDCT systems will be considered at site-specific stage.

4.5.3 Primary Circuit and Liquid Radioactive Waste System

Primary coolant treatment within the Chemical and Volume Control System (CVC) and radioactive liquid effluents processed by the LRW are not within the scope of this chapter. System details are provided in PER Chapter 1 Radioactive Waste Management Arrangements [5] and PSR Chapter B13: Radioactive Waste Management [12]. Monitoring radioactivity of liquid effluent discharges to the environment are detailed in PER Chapter 5: Monitoring and Sampling [6].

The Primary Water Chemistry Strategic Plan for the Holtec Palisades SMR-300 indicates a provisional chemistry regime for the generic SMR-300 [54]. The non-radioactive contaminants in liquid effluent will primarily consist of contaminants such as boric acid and lithium hydroxide. Boric acid is dosed in the primary coolant for reactivity control and lithium hydroxide will be added for pH control to minimise corrosion.

Deborating bed demineralisers in the CVC may be used to reduce boron concentration in the primary coolant at the end of the core life [55]. This measure reduces the quantity of boric acid in liquid effluent that would be discharged to the environment.

When dosing boric acid, the pH of the Reactor Coolant System (RCS) is lowered. To compensate, lithium hydroxide is dosed into the primary coolant for pH control and to minimise corrosion. Lithium hydroxide is abated by the ion exchange resins in the LRW and upstream demineralisation processes, but residual quantities of this contaminant may be discharged to the outfall, along with boric acid [55].

4.5.4 Secondary Circuit

The secondary circuit includes the Steam Generator Blowdown System (SGB) and the Main Feedwater System (MFS). The SGB and the Condensate Polisher System (CPO) reduce the accumulation of corrosion products and solutes within the Steam Generator (SGE) secondary side water and maintains water chemistry within acceptable limits. The blowdown from the SGB is filtered and purified in the CPO for blowdown recovery to the MFS. The SMR-300 Secondary Water Chemistry Strategic Plan [56] defines the secondary chemistry regime for the generic SMR-300 [56].

The secondary circuit is dosed with pH raising agents to manage corrosion. Standard industry practice is to use chemicals such as ammonium hydroxide, hydrazine and ethanolamine. Blowdown can be recovered and filtered via the CPO for reuse. When recovery is not desired blowdown flow can be transferred directly to the Waste Water System (WWS) for disposal [57]. These chemicals will typically be present in the blowdown water when discharged. If SGE secondary side water would not meet discharge limits, temporary equipment can be connected for draining and collecting contaminated SGE water for treatment or disposal

Oxygen scavenging chemicals such as hydrazine will be used during normal operation and dosed during wet lay-up in shutdown operations to minimise corrosion through the removal of oxygen. Any contaminated fluid resulting from the wet lay-up activities will require treatment to destroy the hydrazine before it is discharged. When dosing hydrazine, secondary side chemicals such as ammonia and amines are sometimes produced.

The SGE has the function for nitrogen sparging and blanketing the secondary side to support wet layup when the SGE is not in operation [56]. Wet layup protects the SGE from corrosion and uses water dosed with corrosion inhibitors. Post-GDA design development of the SGE will enable determination of waste streams for its operating modes. Conventional waste stream information will be used to update the generic SMR-300 Integrated Waste Strategy [58] (Table 8: Future Evidence, CIA_03).

4.5.5 Annular Reservoir

The AR is a large body of water that fills part of the interspace between the Containment Enclosure Structure (CES) and the Containment Structure (CS). Its purpose is to serve as the “ultimate” heatsink for decay heat either from the Secondary Decay Heat Removal System (SDH) or via the Passive Containment Heat Removal System (PCH). Further information on the AR and its requirements can be found in Part B Chapter 20 of Holtec Britain’s PSR [59].

With reference to the Holtec SMR-300 System Design Description for the PCH [60], the total volume of AR water in gallons is 1,805,000 gal. In litres this is approximately 6,833,000 L (using 3.78541 litres to the US liquid gallon). The DWS supplies makeup water to the AR as required, as the AR vents to CES atmosphere it will experience some evaporative losses.

Chemistry control of the Holtec Palisades SMR-300 AR will be achieved through dosing of hydrogen peroxide (H_2O_2) as a biocide and sodium hydroxide (NaOH) for pH adjustment [61]. Chemical dosing is essential to minimise corrosion and biofouling that can contribute to the degradation of water quality in the AR. Post-GDA decision making on chemical control will clarify the dosing arrangements for the AR and other cooling water systems for the generic SMR-300. This information will inform the characterisation of chemical properties of effluents generated during plant operation (see Table 8: Future Evidence, CIA_04).

Over the lifetime of the SMR-300 the AR may require emptying and re-filling on an infrequent basis to facilitate internal maintenance. The intended strategy for EIMT has not been defined in detail at GDA, PSR Chapter B9: Description of Operational Aspects and Conduct of Operations [10] provides an overview on the approach to EIMT. Provision has been provided for a connection to a temporary submersible dewatering pump in the AR, if draining the water volume. The bulk effluent is then subject to pH monitoring before discharge. At the GDA Design Reference Point (DRP) [62], the PCH Piping and Instrumentation Diagram (P&ID) [63] identified effluent as directed to the Storm Drain. Further design development of Holtec Palisades SMR-300 has revised the AR effluent waste route to the WWS.

4.5.6 Non-process Effluents

The main sources of non-process effluent for the generic SMR-300 are described within this sub-chapter. Volume figures and detailed characteristics of non-process effluent will be defined beyond GDA timescales in the Emissions Summary Report (see Table 8: Future Evidence, CIA_04).

Sewage Effluent

Sewage effluent arising from the generic SMR-300 will be routed to a municipal Waste Water Treatment Plant (WWTP). Exact considerations on how the generic SMR-300 might link to a municipal WWTP is a site-specific consideration. Sewage effluent is expected to exhibit typical sewage water characteristics and be free from additional chemical or radioactive species arising from the generic SMR-300.

Surface Water Runoff

Surface water drainage for the generic SMR-300 is under development and subject to further design. The drainage configuration, volume loading, treatment equipment, and subsequent discharge arrangements of surface water systems will be confirmed at the site-specific stage.

For onsite road runoff standard design features such as oil and grit separators are expected to be included as appropriate measures prior to discharge, in accordance with industry expectations and best practice [64], before discharging into a local waterbody

Laundry Systems

Laundry systems are outside GDA scope and the design of any laundry systems will be addressed at the site-specific stage.

Firewater

Firewater comprises the runoff from fire-fighting activities and may contain soot, particulate matter, debris, fire suppressant chemicals, oils and grit. The drainage systems for firewater are outside GDA scope; however, typical management of firewater is collection into the surface drainage system. Treatment options are to be assessed to takes into account site-specific factors (see Table 8: Future Evidence, CIA_05).

4.5.7 Waste Water Treatment System

Effluents arising from the secondary circuit and balance of plant equipment (e.g. auxiliary boiler and non-radioactive floor drains) will transfer to the on-site Waste Water Treatment (WWT) system before discharge via the site outfall [49]. Suitable treatment technology options will be assessed beyond GDA timescales to take into account site-specific factors (see Table 8: Future Evidence, CIA_05).

If in the event of a leak of radioactivity into the secondary circuit, effluent contaminated with radionuclides would be re-directed to the LRW for further treatment. Details of monitoring arrangements for secondary systems to detect ingress of radioactivity are presented in PER Chapter 5 [6].

Treated effluent from the WWT may be routed to an offsite municipal WWTP if required [49], transfer of treated effluent to a municipal WWTP would be limited to waste streams that comply with discharge permits or consents and meet acceptance criteria of the WWTP.

4.5.8 Contaminants in the Generic SMR-300 Effluents

Through the review of the main effluent sources present in the generic SMR-300 [49], a list of potential non-radiological contaminants have been profiled in Table 4.

Table 4: Generic SMR-300 List of Sources of Contaminant in Effluent Arisings

Effluent Source	Potential contaminants	Treatment and Discharge System
CRS/SWS blowdown.	• Biocides (e.g. chlorine, glutaraldehyde). • Scale inhibitors. • Corrosion inhibitors (e.g. hydrazine). • Polymer dispersants. • Trace solutes and solids (e.g. chlorides, sulphates).	CRS/SWS.
SGE blowdown.	• Ammonia, ethanolamine. • Hydrazine. • Amines. • Trace solutes and solids (e.g. chlorides, sulphates).	• Treatment for reuse via CPO. • Effluent discharge to WWT (treatment technology to be determined).
AR.	• Sodium Hydroxide. • Hydrogen Peroxide. • Sodium Molybdate.	WWS (treatment technology to be determined).
Conventional contaminants from Nuclear Island floor and equipment drains.	• Boric acid. • Lithium hydroxide. • Trace solutes and solids (e.g., chlorides, sulphates).	LRW – Deborating bed demineralisers
Turbine Island and Balance of plant equipment and floor drains.	• Chemical drain effluent. • Oily drain effluent.	WWT under normal operation. LRW if radionuclides are detected.
Sewage waste water.		Municipal WWTP.
Surface water runoff.	Oil contaminants (e.g. from site vehicles).	Oil separators and Storm Drains.

4.5.9 Thermal Impact of the Generic SMR-300

Thermal energy from generic SMR-300 systems is principally released to atmosphere via water evaporation from the MDCT systems. A proportion of the waste thermal energy is transferred to the cooling water circuit and subsequently released as blowdown water to the local waterbody. The thermal and chemical impacts of discharging effluents from the outfall will be determined at the site-specific design stage through plume modelling and environmental assessment (Table 8: Future Evidence, CIA_06).

4.5.10 Water and Heat Efficiency

As the design of the generic SMR-300 is developed, opportunities to further integrate water and heat efficiency may present themselves. For this fundamental assessment, options for consideration in later design are discussed here. These options will be considered alongside other requirements such as safety, security, cost, and feasibility.

Depending on site-specific factors, heat pump technology may be employed to upgrade waste heat from MDCT systems to a quality enabling district heating, provided a viable consumer can be identified. With a high secondary superheat, the generic SMR-300 is amenable to co-generation, district heating, or process heat applications, for example:

- Agriculture (heating greenhouses).
- Aquaculture (fish farming).
- District Heating options.
- Desalination.

Given that opportunities for the beneficial re-use of waste heat will be dependent on location, this is a topic that will be explored more fully at the site-specific stage.

4.5.11 Discharges to Surface Water Summary

Discharges to surface water are from the outfall of the generic SMR-300. This design aspect is outside the scope of this GDA. Treatment of discharges will be conducted prior to discharge to ensure effluents meet acceptable limits as outlined in EPR16 [34].

Biocides, pH adjustment and corrosion inhibitors, scale inhibitors are set out in the chemical strategies for water-using systems in the generic SMR-300. The chemicals provisionally selected are known to be used in NPPs and their management and treatment will follow good practice. The generic SMR-300 chemical inventory remains underdevelopment and future work will be conducted as the design develops. This is essential not only to understand how the plant will minimise impact to the environment, but also to ensure safety of workers, efficiency of plant and longevity of SSCs.

Thermal impacts of effluent discharges will be calculated once a detailed design has been developed. Most waste heat will be rejected to atmosphere, based on the assumption of MDCT technology for the cooling technology. At site-specific stage, options for re-use of waste heat can be explored to improve the efficiency and sustainability of the plant and local beneficiaries (e.g. district heating users).

Environmental impacts (thermal and contaminant discharge) will be managed in accordance with permit requirements when they are set. The work done during this step-two GDA forms the basis for future assessments, and commitments and requirements for future design work.

4.6 DISCHARGE TO GROUNDWATER

This sub-chapter describes the aspects of the generic SMR-300 relevant for discharges to groundwater.

4.6.1 Discharges to Groundwater

There are no planned discharges to groundwater. The generic SMR-300 design includes SSC that are below grade, i.e., below ground level, as described in Holtec SMR-300 Plant Overview [51].

The generic SMR-300 Codes and Standards report [65] sets out the codes and standards applied to ensure structural integrity and leak-tightness of SSCs. The application of these engineering standards and best practice is to prevent leakage of radioactive material and non-radioactive polluting substances.

Sources of non-radioactive pollutants will be appropriately designed to prevent land and groundwater pollution, for example using CIRIA guidance C736 [36]. Storage of fuels, oils, etc., will utilise best industry practice such as bunding and liners to mitigate consequences of accidental release, in accordance with the Health and Safety Executive (HSE) Secondary containment Technical Measures Document [66] It is good practice to include leak detection systems, spill kits and emergency protocols, and ensure good maintenance and repair of any bunding, storage tanks and sumps.

4.6.2 Prevention of Accidental Discharges of Radioactive Waste to Land and Groundwater

Radioactive waste management is covered in PER Chapter 1 [5] and PSR Chapter B13 [12]. Radioactive waste is managed through application of the waste hierarchy, which prioritises waste prevention and minimisation .

The fundamental principles of BAT and As Low As Reasonably Practicable (ALARP) are applied to radioactive waste management in the generic SMR-300 to prevent and minimise radiological impacts to workers, members of the public and the environment. The baseline strategy for radioactive waste management is detailed in the SMR-300 Integrated Waste Strategy [58]. Decisions taken in relation to management of radioactive waste have considered the optioneering guidance for the generic SMR-300 [67] and HI-2241304, SMR-300 UK GDA ALARP Guidance Document [68]) to provide an optimised solution through a risk-informed lifecycle approach.

Possible sources of accidental discharges of radioactive waste to land and groundwater stem from liquid and gaseous radioactive wastes, either from leakage of radioactive aqueous effluent or deposition of particulates from gaseous radioactive waste. These radioactive wastes have practicable management measures which are assessed separately to this chapter. For more detailed information, refer to PER Chapter 1 Radioactive Waste Management Arrangements [5] and PER Chapter 5 Monitoring and Sampling [6].

Industry good practices in radioactive waste processing systems established as requirements by Electric Power Research Institute (EPRI) in their Utility Requirements Document [69], have informed the generic SMR-300 design of the LRW and Gaseous Radwaste System (GRW). In addition, the generic SMR-300 will adhere to applicable United States Nuclear Regulatory

Commission guides, which set a high standard for the design, quality assurance, operation and maintenance of radioactive waste SSCs. Leak rates for piping and GRW components will be within the tolerable limits specified in ANSI/ANS 55.4. A full list of the applied codes and standards may be found in PSR Part B Chapter 13 Radioactive Waste Management [12].

4.6.3 Discharges to Groundwater Summary

There are no planned discharges to groundwater from the generic SMR-300. All potential for contamination of groundwater from unplanned leaks will be assessed as part of future design development, and it is expected that appropriate leak-tightness measures and leak detection monitoring will be designed below grade in the generic SMR-300.

4.7 OPERATION OF INSTALLATIONS (COMBUSTION PLANT AND INCINERATORS)

This sub-chapter describes the GDA requirements, regulatory context, and design considerations for combustion plant and incinerators within the generic SMR-300 design, as well as proposed assessments for how this will be managed post-GDA. An Air Quality Report was developed in Step 2 to review combustion plant present in the generic SMR-300 [70]. The following discussion in this sub-chapter is supported by the detailed discussion in the Air Quality Report.

There are no incinerators present in the generic SMR-300 design. The design of SBDs and auxiliary boilers are out of scope for this GDA; however, a review of the provisional design documentation and similar systems present in the Holtec Palisades SMR-300 have informed the following discussion.

4.7.1 Combustion Plant in the Generic SMR-300

SBDs are used to provide Alternating Current (AC) power to non-safety systems, such as HVAC and auxiliary systems, in the event of a Loss Of Off-site Power (LOOP) event. They are not classed as emergency or security generators at this stage of the design, and will not be relied on for safe shut-down of the plant [70], [71].

The auxiliary steam system supplies steam for deaerator heating and gland sealing steam during unit heat up, start-up, shutdown and cooldown. If both units are offline, auxiliary steam will be supplied via the auxiliary boiler [71]. Auxiliary steam will not be required during any emergency or abnormal operations, including during a loss of the electrical grid , but may optionally be used to supply power to non-safety systems in the event of a Station Blackout (SBO). It is not expected that both the SBDs and auxiliary boilers will need to be operating at the same time [70], [71].

The Holtec Palisades SMR-300 plot plan indicates an Auxiliary Boiler Building (ABB) and a Diesel Generator Building (DGB) [72]. Though out of scope for this GDA, these structures and combustion plant activities will be present in the generic SMR-300 design.

Provisional design work indicates a single auxiliary boiler for the generic SMR-300 with a total thermal input of approximately 21.7 MW_{th}. There is likely to be a maximum of four diesel SBDs in the generic SMR-300, each with a thermal input of approximately 6.54 MW_{th}. An alternative design utilising two large SBD, supplying the same total output Megawatt electrical (MW_e) power as the four smaller SBD is also under consideration. This is subject to design development and will be confirmed post-GDA. Table 5 summarises the combustion plant output and input power.

Table 5: Summary of Power Input and Outputs of Combustion Plant for the Generic SMR-300 [70]

Source	Power output (MW_e)	Power input (MW_{th})
SBD (total of 4)	10	26.16
Auxiliary Boiler (total of 1)	18.64	21.7
Total Combustion Plant	**28.64**	**47.86**

Diesel Generators

For the purposes of determining if SBDs will be subject to environmental permitting regulations, it is necessary to understand the nature of their operation (emergency or non-emergency). Diesel generators which are solely for emergency purposes do not typically require a permit on nuclear licensed sites. It is anticipated that the generic SMR-300 SBD will be classed as non-safety related, meaning that they are not required for safe shutdown of the plant; however, this may be subject to change as design progresses. For the purposes of this assessment it is assumed that the SBD will fall under EPR16, and therefore should be included in the whole site MW_{th}. The determination as to whether the SBDs are subject to EPR16 will be made post-GDA.

The current design has four $2.5MW_e$ SBDs, totalling 10 MW_e thermal output. The precise number of generators is to be confirmed as the thermal output from the generators could be supplied across two SBDs with a thermal output of 5 MW_e per generator. The expected mission time for the SBDs is 72 hours. This is timeframe needed to charge the Class 1E batteries. During this time the SBDs may also provide power to non-safety systems [71]. However, the standby generators (and corresponding fuel stores) have capacity to provide power for up to seven days if required [51].

As the standby generators are expected to be diesel fuelled, pollutants such as CO_2, NO_x, SO_2, carbon monoxide and particulate matter at varying sizes are likely to be generated during use. Annual emissions of the above pollutants from these combustion sources are expected to be low. Nonetheless, this will be reviewed as design develops for the generic SMR-300 and assessed as part of the normal permitting process for the plant.

Auxiliary Boiler

The primary purpose of the auxiliary boiler is to provide steam during unit start-up. Boiler type and technology are not currently specified for the generic SMR-300 design, therefore it is not possible to determine exact emission rates and constituents. It is expected that the auxiliary boiler mission time will be a maximum of 72 hours.

Based on the paper on the Standby Generator and Auxiliary Boiler Fuel Source and Emission Limits [71] for Holtec Palisades SMR-300, options for the fuel technology of the auxiliary boiler are still under consideration for the generic SMR-300 design, but may include:

- Diesel fuelled.
- Natural gas fuelled with diesel back-up.
- Natural gas fuelled.

The specification of a particular fuel source for the auxiliary boiler will be a site-specific consideration, as natural gas may be sourced from local supply or could be stored on-site. At GDA, options have not been foreclosed. Emissions from the auxiliary boiler are likely to be: CO_2, NO_x, SO_2, carbon monoxide, and particulate matter if diesel fuel is used; or methane, CO_2, NO_x, and SO_2 if natural gas is used.

4.7.2 Environmental Permitting and Regulatory Considerations

The concept design for the generic SMR-300 indicates a single auxiliary boiler for the generic SMR-300 with a total thermal input of approximately 21.7 MWth. There is likely to be a maximum of four diesel SBDs in the generic SMR-300, each with a thermal input of approximately 6.54 MWth. An alternative design utilising two large SBD, supplying the same total output MWe power as the four smaller SBD are under consideration. This is subject to design development and will be confirmed post-GDA. Table 5 summarises the combustion plant output and input power and based on these figures a thermal efficiency of 85.9% for the auxiliary boiler and 38.2% for the SBDs is assumed. The aggregated thermal input for the combustion plant installations have been estimated to be 47.86 MW_{th} which means that the generic SMR-300 design currently sits within the MCPD [19]. Future design updates may increase the total aggregated rated thermal input which could place the generic SMR-300 within the remit of the IED [37] (see ,Table 8: Future Evidence, CIA_07).

The specific environmental permit to be applied for will depend on site-specific parameters, including nearby sensitive receptors and meteorological data. An air quality screening assessment is required as part of the permit application (Table 8: Future Evidence, CIA_08).

At a later stage of design, there may be additional diesel fired equipment such as a diesel fire pump and a backup diesel air compressor which will impact the applicable legislation. The fuel source for combustion plant will be confirmed at a later stage of the project, at which point a reassessment of the environmental permitting requirements can be conducted.

The plant will require a GHG monitoring methodology in accordance with the UK ETS [39] as the aggregated thermal input for the generic SMR-300 design is greater than 20 MW_{th}. A comparison of the proposed technology against the relevant guidance will be required (see Table 8: Future Evidence, CIA_09).

4.7.3 Environmental Protection and Control

Mitigation techniques will be considered when the fuel types of combustion plant are confirmed. Post-GDA SMR-300 design development will assess pollution control, abatement and mitigation means such as flue gas monitoring and High Efficiency Particulate Air (HEPA) filtration. The prospective operator will develop and apply good management protocols as part of operating an effective environmental management system for the site.

4.7.4 Operation of Installations Summary

The generic SMR-300 will have combustion plant on-site, though the design of these facilities is outside the scope of this GDA. It is known that SBD and an auxiliary boiler will be used, and at this early stage of the design it is expected that diesel, natural gas, or a combination of these fuels will be used. Combustion technologies generate air pollutants; however, the operation of combustion plant will be limited to very specific demands, including start-up and LOOP scenarios.

Environmental impacts from combustion plant are primarily related to air emissions during operation of the SBD and auxiliary boilers. The mission time for the combustion plant is expected to be a maximum of 72 hours; however, there is limited information available on the emissions as the boiler and generator technologies are yet to be selected. This will be reassessed as design develops to inform design and ensure minimal environmental impacts.

Site total MW_{th} is estimated near the threshold limit of 50 MW_{th}. This is based on assumptions and existing design documentation from Holtec Palisades SMR-300 and SMR-160 designs. Therefore, it is expected the MCPD will apply, with the possibility that the IED may also apply.

Once specific technologies for combustion plant have been selected a full assessment of thermal efficiencies and emissions can be undertaken for the generic SMR-300 and an environmental permit applied for operation installations.

4.8 CONTROL OF MAJOR ACCIDENT HAZARDS (COMAH)

This sub-chapter discusses areas of the generic SMR-300 which need to be considered for future COMAH regulations as well as proposed assessments for how this will be managed. The discussions in this sub-chapter are supported by the findings of a high-level COMAH screening assessment conducted during Step 2 of this GDA process [73].

This screening assessment identified the likely presence of a number of chemicals which are classed as dangerous substances under COMAH regulations. A conservative approach has been taken, and forward actions recorded to review the findings of the screening assessment once the full chemical inventory of the generic SMR-300 is developed. The output of this work will support future design and site operators to be compliant with the regulations of COMAH15 [21].

4.8.1 COMAH Chemicals Present in the Generic SMR-300

As part of the COMAH screening assessment, a review of water chemistry documentation and design information of storage tanks was conducted to identify the presence of dangerous chemicals [73]. Volumes were estimated where storage tank size information was available in the generic SMR-300. Concentrations are in development as part of normal design progression, therefore unless otherwise specified 100% concentration has been assumed to give the most conservative assessment. The exception to this is hydrazine, where it is provisionally known that two design options are in consideration, 35% concentration and 5% concentration. For the purposes of this chapter, conservatively 35% concentration has been assumed.

The estimated volumes and concentrations of applicable chemicals within generic SMR-300 design were compared with their threshold limits in Schedule 1 of COMAH15 [21]. The results on the likelihood of exceeding the lower-tier or upper-tier threshold are summarised in Table 6. The list will be subject to change as part of post-GDA design development.

Table 6: COMAH Substances Provisionally Identified in Generic SMR-300 Design Documentation

Dangerous substance	Use within SMR-300	Lower Tier Threshold (tonnes)	Upper Tier Threshold (tonnes)	Likelihood of applicability of COMAH15 regulations
Acetylene	Welding.	5	50	Unlikely to exceed lower tier threshold.
Ammonium Hydroxide	Generated as a byproduct.	100	200	Unlikely to exceed lower tier threshold.
Boric Acid	Neutron Absorber.	50	200	Unlikely to exceed lower tier threshold.
Diesel	Storage and use for diesel generators.	2500	25000	Unlikely to exceed lower tier threshold.
Glutaraldehyde	Biocide in Component Cooling Water System (CCW).	50	200	Unlikely to exceed lower tier threshold.
Hydrazine	Oxygen scavenger in the RCS and MFS.	0.5	2	Lower tier establishment very likely, upper tier establishment is possible.

Dangerous substance	Use within SMR-300	Lower Tier Threshold (tonnes)	Upper Tier Threshold (tonnes)	Likelihood of applicability of COMAH15 regulations
Hydrogen	Stored for plant wide use, corrosion inhibitor in primary coolant systems.	5	50	Unlikely to exceed lower tier threshold.
Hydrogen Peroxide	Biocide in AR.	50	200	Unlikely to exceed lower tier threshold.
Oxygen	Stored for emergency air supply.	200	2000	Unlikely to exceed lower tier threshold.
Sodium Hypochlorite	Biocide in MDCT systems.	100	200	Unlikely to exceed lower tier threshold.
Zinc Acetate	Corrosion protection.	100	200	Unlikely to exceed lower tier threshold.

Hydrazine is used to control oxygen levels in the RCS and MFS to minimise stress corrosion cracking and maintain structural integrity of plant systems and extending component lifetime. Hydrazine concentration for storage and use is assumed to be at 35%, at this concentration and estimated volumes, it is considered very likely that the SMR-300 will qualify as at least a lower-tier COMAH establishment. Optioneering at site-specific stage will consider a lower concentration of 5%, and applicability of COMAH regulations to hydrazine will be assessed at site-specific stage (see Table 8: Future Evidence, CIA_10).

Further assessments of the full chemical inventory will be conducted post-GDA as part of design development to eliminate uncertainty. If the generic SMR-300 chemical inventory is determined to qualify as a lower-tier or upper-tier COMAH establishment, the required documentation and management protocols will be produced in accordance with COMAH15 [21].

4.8.2 Protection and Mitigation Controls of Dangerous Chemicals in the Generic SMR-300

As the design for the generic SMR-300 progresses beyond the conclusion of GDA, good practice regarding the handling and storage of all chemicals, and in particular those relevant to COMAH will be adopted. Primary, secondary and tertiary containment, and pipework will be designed with safety features in mind. Protocols and management practices will ensure continued safety and assurance of the storage of dangerous chemicals.

Containment structures may be above ground storage tanks or below grade storage tanks. Pipework includes any piping to and from storage tanks, including valves. Design factors for primary containment and piping will consider:

- Materials, design and construction is compatible with the chemical and physical properties of the fluids to be stored.
- Means for preventing excessive vapour generation leading to the build-up of pressure above an unacceptable threshold.
- Structures are designed to withstand plausible impacts which may foreseeably occur during the normal operations of the generic SMR-300.
- Weatherproofing and sealing against ingress of water or air.
- Tolerances for thermal expansion and contraction.
- Tolerances for foreseeable impacts of climate change.

- Ground stability at or in which the storage units are installed.
- Accessible for regular inspection and maintenance as required.
- Aggregation of dangerous chemicals in pipework joints and bends.
- Pipework length is appropriate and at the minimum practicable length while still enabling effective functioning of the systems and adequately supported.
- Isolation of tanks via appropriate valve use.
- Automation of tank gauging systems where appropriate, and remote operation of valves.
- Installation of leak detection and alarm systems linked to shut-off valves.

Storage tanks will be bunded using impermeable and corrosion resistant materials to prevent leakage and escape. The bunding shall be inspected and maintained as part of a regular maintenance protocol in accordance with good practice. Fire protection measures and containment barriers will be subject to design development post-GDA.

4.8.3 COMAH Summary

The generic SMR-300 design incorporates the storage and use of chemicals that are dangerous substances under COMAH. An assessment of generic SMR-300 design documentation and storage tank drawings has identified that hydrazine is the only chemical which is present in amounts above a threshold quantity for COMAH.

Early estimations (based on assumptions and information from Holtec Palisades SMR-300 design) indicate that the generic SMR-300 is very likely to be a lower tier COMAH facility, based on the presence of hydrazine. A conservative approach has been taken, and it has been identified that the generic SMR-300 may possibly be an upper tier COMAH facility, due to the presence of hydrazine. Other chemicals identified do not meet lower threshold quantities therefore are not of a concern for COMAH, though they should be included in future COMAH assessments of the design for certainty. Beyond GDA timescales, a chemical inventory of the plant is will be confirmed (see Table 8: Future Evidence, CIA_11).

4.9 FLUORINATED GREENHOUSE GASES AND OZONE-DEPLETING SUBSTANCES

This sub-chapter provides detail on the regulatory context, and design considerations for any F-gases and ODS associated with this project as well as proposed assessments for how this will be managed. Discussion in this sub-chapter are supported by the RP's Fluorinated Gases and Ozone Depleting Substances Technical Note [74]. This technical note reviewed all available information on possible F-gas and ODS use in the generic SMR-300 design documentation. The Technical Note established that no ODS will be used or stored in the generic SMR-300 design.

Many of the systems likely to use F-gases are out of scope of GDA and therefore a likely scenario has been derived using supplementary information from extant NPPs. All SSCs discussed in this sub-chapter are subject to change in future design development. For the generic SMR-300, the most probable uses will occur in HVAC systems, chillers and cooling systems and FPS.

Environmental assessment taking into account the measures protecting the environment from accidental release of F-gases (see Table 8: Future Evidence, CIA_12) would be conducted at a later stage of design development, when systems are being selected and the choice of refrigerants has been made and captured in the plant chemical inventory.

4.9.1 F-gas Use in the SMR-300

HVAC Systems

The generic SMR-300 HVAC systems are described in PSR Part B Chapter 5 Reactor Supporting Facilities [9]. There are two types of HVAC system, direct exchange systems and chilled water systems. As the name suggests, chilled water systems use water as the coolant, whereas direct exchange systems are likely to use refrigerant gas to directly conduct thermal energy out of the intake air supply and therefore supply cooled air at the output. These systems currently have low design maturity, and the specified refrigerant(s) for both types of system is subject to post-GDA design development. Post-GDA the F-gases used on plant will be identified in a chemical inventory (see Table 8: Future Evidence, CIA_11).

Refrigerant gases include F-gases; however, some alternative refrigerants have been used in some industry applications, for example ammonia, CO_2 and hydrofluoroolefins. These alternative refrigerant gases have a lower Global Warming Potential (GWP) than HFCs, chlorofluorocarbons (CFC), and SF_6. These refrigerants may also have properties which make them unsuitable for use in a nuclear licenced site, for example, due to flammability, explosiveness, toxicity, poor efficiency or complex storage requirements. UK government guidance on use of F-gases in air conditioning and heat pump systems can be used for identifying current and future banned F-gases [24]. The choice of refrigerant will also need to consider personnel safety considerations, feasibility and environmental safety, and is subject to future design optioneering. Good engineering practice, and compliance with UK legislative requirements will ensure leak prevention and detection mechanisms are designed into these systems.

Fire Protection System (FPS)

In the generic SMR-300 design, FPS comprise single hand-held fire extinguishers through to automatic integrated sprinkler systems, as described in Holtec Britain's Conventional Fire Strategy Document [75]. Broadly FPS may refer to evacuation plans, routes, alarm systems and architectural considerations; however, for the purposes of this discussion, only fire suppressant agents are considered as these are the only aspects of the FPS which may contain F-gases. Fire suppressant agents include water, foam, power, CO_2 and wet chemical extinguishers. Historically some FPS used HFC-23, which is now banned in the UK and will not be used in the generic SMR-300. The generic SMR-300 may include other (non-banned) F-gases as a fire suppressant agent, for example, in structures containing electrical switchgear. In such areas, water is not an appropriate fire suppressant agent due to its conductivity.

Conventional fire risks, which input directly to FPS design, is provided in the Risk Identification Report for UK Conventional Fire Safety Design [76]. The scope of this report is limited to the GDA scope.

4.9.2 Commercial Off-The-Shelf (COTS) Equipment

Chillers, refrigerant plant and single hand-held fire suppression units in the generic SMR-300 will comprise COTS equipment. A future procurement plan will set out the standards and UK legislative requirements that the supply chain will need to comply with. As the design progresses, assessments will be made on selection of equipment using F-gases. The design decision for specific equipment must consider all commitments to health, safety, security, and the environment to ensure that the impact of the facility is reduced, and all requirements are met. These procurement specifications will be required at the site-specific stage.

Equipment containing F-gases will be managed through the prospective operator's environmental management systems. Adequate record keeping of maintenance history for this equipment will be ensured through the environmental management systems.

4.9.3 Management of Equipment using F-gases

In line with the UK government guidance [77], use of F-gases and servicing of equipment containing F-gases will require qualified technicians who are qualified to work with F-gases. This is an operational consideration, but management plans and procedures can be set as design develops to ensure environmental protection is embedded in the project.

Regular inspection, testing and maintenance of any equipment containing F-gases can be enacted through an F-gas management policy, and records of such testing and inspections, any repairs carried out, should be kept to provide a complete audit trail throughout the lifetime of the plant.

Procurement strategies should include specifying qualified technicians to be engaged for maintenance and repairs on a regular basis. Further, review of the UK legislation relating to use, storage, and management of F-gases should be conducted at regular intervals throughout the design stage of the project to ensure no banned substances are specified in design documents and drawings [78].

4.9.4 F-gas and ODS Summary

Equipment containing F-gases is not yet defined in the generic SMR-300. A review of design documents had indicated the likely use-cases for F-gases and the systems which could contain F-gases such as HVAC, FPS and chillers/refrigeration units. These systems may use refrigerants containing F-gases, or fire suppressant mediums including F-gases, though alternatives will be considered where available. No ODS will be used in the generic SMR-300.

It is possible that the design will opt to obtain COTS units for the equipment containing F-gases, particularly for small HVAC units, hand-held fire suppressant units (e.g. fire extinguishers) and refrigeration units in welfare areas of the generic SMR-300 (kitchens, bathrooms, storerooms). For COTS units, the selection of refrigerant is largely dictated by market supply and availability. Selection of preferred materials will need to consider safety and security, as well as other properties of refrigerants (combustibility, toxicity, etc.), to ensure the most appropriate refrigerant is used, while maintaining compliance with UK F-gas regulations.

SMR-300 systems containing F-gases will be maintained and repaired by qualified personnel. The prospective operator will be responsible for ensuring adequate checking, maintenance and good record keeping of equipment containing F-gases.

4.10 SUSTAINABILITY

This sub-chapter details sustainability of the generic SMR-300 in relation to expectations outlined in the EA GDA Guidance for RPs [3]. The SMR-300 GDA Sustainability Strategy [79] set out the key sustainability obligations, UN SDGs [42] and the framework of Buildings Research Establishment Environmental Assessment Methodology (BREEAM) Infrastructure [80]. This work will form the basis for embedding sustainability into the project at this early stage.

The UN SDGs comprise 17 high-level goals relating to sustainability which can be applied by organisations globally. The UN SDGs are necessarily wide-ranging in scope and aim to provide a framework for companies to aim for when setting their own sustainability obligations and targets. The 17 goals were selected as they tackle global environmental and societal issues which are deemed to be most important in achieving sustainable and thriving human development. Table 7 lists the goals that are considered to best apply to the generic SMR-300.

Table 7: UN SDGs Relevant to the Generic SMR-300

UN SDG Goal	Description of how the generic SMR-300 contributes/will contribute
Goal 6: Clean water and sanitation	The generic SMR-300 will interface with local surface water sources and local municipal water supplies and treatments.
Goal 7: Affordable and clean energy	The generic SMR-300 project contributes to the provision of clean energy.
Goal 8: Decent work and economic growth	The generic SMR-300 can provide the opportunity for long-term work for the local area during construction, operation and decommissioning.
Goal 9: Industry, innovation and infrastructure	The generic SMR-300 provides an innovative solution to improve the energy infrastructure and energy network.
Goal 11: Sustainable cities and communities	The generic SMR-300 may provide clean energy to the local area and optionally may provide district heating options from waste heat.
Goal 12: Responsible Consumption and production	The generic SMR-300 may develop a sustainable procurement plan to identify the best sources of materials and resources for the project.
Goal 13: Climate action	The generic SMR-300 would be another step toward decarbonising the energy industry in the UK.
Goal 14: Life below water	The generic SMR-300 will be compliant with UK regulatory requirements to protect life below water from water abstraction and discharges.
Goal 15: Life on land	The generic SMR-300 project will be compliant with UK regulatory requirements to protect life on land from emission to air and land.

The UN SDGs underpin a lot of sustainability policies and objectives; however, they are difficult to measure progress and improvement against. This is why Holtec Britain also used the BREEAM Infrastructure framework to identify areas of the generic SMR-300 which contribute to sustainability.

BREEAM Infrastructure is an assessment methodology which sets out a framework of environmental and sustainability considerations for a construction project, specifically infrastructure projects. It was formerly known as the Civil Engineering Environmental Quality Assessment & Award Scheme (CEEQUAL). These assessments require evidence to be provided against a set of criteria: energy performance, carbon emissions, water consumption and resources, management, health and wellbeing, communities and stakeholders, transport, landscape and visual impacts, biodiversity and more. An overall score indicates how well a project is aligned or has been able to prove alignment with those criteria.

4.10.1 Environmental Objectives of the Requesting Party

Holtec International has embedded sustainability into their company culture through their mission statement and Environment Justice Mission Statement [81]. Holtec Britain have defined sustainable development in line with the UN SDGs and the Department for Environment, Food & Rural Affairs (DEFRA)'s Environmental principles policy statement [82]:

"Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. It involves trying to achieve environmental benefit alongside economic growth and social progress and should be considered in a global context."

This definition is aligned with the EA and NRW's duty to promote sustainable development while protecting or enhancing the environment, and with the Well-being of Future Generations (Wales) Act 2015 [44] and other supporting legislation. Holtec Britain has embedded sustainable development in its Environmental Policy [83] with the following commitments:

- Support policies that advance the generation and use of low carbon, reliable nuclear powder to protect the health, environment and economic well-being of communities.
- Integrate environmental justice considerations and sustainable development principles into our company business practices, including those related to selection of contractors and suppliers.

Environmental protection and enhancement is supported by the work conducted at Step 2 GDA in relation to EPR16 [34] (and supporting and related legislation) and the Radioactive Substances Regulations (RSR): objectives and principles [84] throughout the PER. In particular, the Environment Act 1995 specifically states that it is the aim of the EA to "…*make the contribution towards attaining the objective of achieving sustainable development"* [43].

4.10.2 Approach to Design Optimisation in Generic SMR-300

Application of BAT in developing the generic SMR-300 ensures that the harmful effects of ionising radiation is kept As Low As Reasonably Achievable (ALARA). Further detail on how RSR BAT is discussed in the Approach and Application to the Demonstration of BAT [7]. The principles of BAT may also be applied to non-radiological pollution prevention and control, and the development of the generic SMR-300 design will take into account relevant EU BREF notes.

Optioneering and design decisions will be conducted with sustainable development in mind. SMR-300 GDA RSR-BAT Guidance [67] incorporates the sustainability criteria listed below to consider in assessing design options. These considerations must be balanced against the cost, safety, security, time, and other engineering requirements, across the whole lifecycle of the project.

- Use and minimisation of energy and material resources.
- Wider or future uses of new facilities/equipment/structures.
- Socio-economic impacts including:
    - Sustainable procurement and supply chain opportunities.
    - Noise, landscape and visual Impacts.

    - Transport.
- Recycling of materials.
- Re-use of equipment vs "one-off" use.
- Land contamination.
- Carbon (emitted and embodied) reduction opportunities.
- Action against climate change.
- Climate change risks and vulnerabilities (to the design from the effects of climate change).

4.10.3 Sustainability in the Generic SMR-300 Design

The Holtec SMR-300 GDA Sustainability Strategy [79] identifies key areas for sustainability that can be developed further post-GDA.

Carbon Accounting

Fundamentally, the SMR-300 contributes to sustainable development by providing low carbon energy through development of SMR technology, specific areas of the generic SMR-300 provide clear sustainable benefits. It is not within the scope of this GDA to conduct a carbon assessment, as specified materials and sourcing of materials is subject to detailed design. However, opportunities have been identified to conduct Scope 1, 2, and 3 carbon emissions accounting for Holtec and the supply chain. Scope 1 emissions are a direct result of the organisation's activities. Scope 2 emissions are indirect from purchased electricity, heat or steam. Scope 3 carbon emissions are those resulting from organisation's supply chain e.g. transportation of materials, transport, staff travel to work, waste disposal [85].

Climate Change Adaptation and Resilience

PSR Part B Chapter 21 External Hazards [13] impacts of future climate change are considered in relation to the risk to a potential future SMR-300 site from the environment. The UK Climate Projections 2018 (UKCP18) data have been used to derive the generic site envelope parameters, in particular those relating to flood risk, ambient air temperatures, maximum hot ambient temperatures and minimum cold ambient air temperatures. The requirements on the design, set by the ONR, will ensure that climate risks and vulnerabilities are considered carefully in design decisions to ensure safe and effective functioning of the facility within reasonable foreseeable climate conditions.

Post-GDA a Climate Change Adaptation Risk Assessment will be developed in order to manage impacts and track risks specifically from climate change to ensure resilience of facilities to future climate change (see Table 8: Future Evidence, CIA_13). In conducting such a risk assessment, appropriate climate scenarios over the lifetime of the project will be selected using the latest UK Climate Projection data [86].

Sustainable Management of Natural Resources

The generic SMR-300 has a service life of 80 years appropriate maintenance and longevity of components enables resources to be appropriately optimised and materials used efficiently without exhausting essential resources. Through eliminating the requirement for further construction and decommissioning periods this lowers associated emissions that come with these processes, in turn reducing waste, conserving energy and the projects overall carbon footprint.

The generic SMR-300 has features which will enable sustainable operation. For example, careful development of the chemistry regimes as discussed leads to prolonged SSC life, therefore reducing the need for replacement components to be manufactured, transported and installed. Through this any carbon footprint associated with those activities is eliminated or significantly reduced.

Use of waste heat, as discussed above, and recycling of non-radioactive coolant chemicals and water contributed to sustainable use of natural resources. The design has possible useful applications for waste heat as it has high secondary superheat, meaning it is amenable to co-generation, district heating or process heat applications.

New construction sites in the UK are advised to implement a Sustainable Drainage Systems (SuDS) strategy [87]. This includes the development of infrastructure for flood prevention and water management during extreme weather events. Requirements of the strategy vary depending on site-specific requirements, including local flood risk and weather patterns. Implementation of SuDS may present additional opportunities for water recycling and re-use in the generic SMR-300, for example, through rainwater harvesting. Moreover, nature-based solutions (such as wetlands or green rooves) will demonstrate value to Biodiversity Net Gain (BNG) or equivalent plans, if applicable.

Long-term Lifecycle Impacts

The generic SMR-300 considers long-term lifecycle impacts at the outset, in particular with respect to waste management. Long term storage considerations for spent fuel are necessary to ensure public safety and environmental protection.

Assessments on ecology will occur at site-specific stage. As a long-term project having a life-time of at least 80 years, the generic SMR-300 has the opportunity to develop and manage a BNG or equivalent programme having a long-term positive impact on the environment.

Contribution to a Circular Economy

Waste management represents an area where sustainability considerations have been incorporated into the design, for example the consideration of the waste hierarchy principles to mitigate any negative effects of radioactive waste on the public or environment. An Integrated Waste Management Strategy has been developed in Step 2 of this GDA to link together all aspects of waste management as currently covered in the generic SMR-300 [58].

The radioactive waste management process will be optimised with respect to safety, technical feasibility, environment and socio-economic factors, more information on the sustainability of the radioactive waste management arrangements can be found in PER Chapter 1 Radioactive Waste Management Arrangements [5]. The use of Multi-Purpose Canisters (MPCs) with a large capacity for spent fuel assemblies reduces the quantities of materials needed per unit volume of waste. Further information on the waste canisters, and corresponding SFSI can be found in PSR Part B Chapter 24 [15]. Additionally, the use of a fully integrated dry fuel storage system avoids excluding alternative spent fuel management strategies in the future.

Decommissioning protocols include a plan for the site to be returned to green field following decommissioning. The plant is also built with decommissioning in mind. More detail can be found in Chapter B25 of the PSR: Construction and Commissioning [88]. The nuclear industry has strict requirements on waste storage and waste management due to the radioactive nature of certain waste streams. Therefore, the generic SMR-300 project incorporates circular economic principles as a function of that requirement for radioactive waste streams. This mindset therefore expands to other waste streams as evidenced through the Integrated Waste Strategy [58].

Communities and Stakeholders

Although consideration to communities and stakeholders is not a requirement in GDA Guidance for RPs [3], it has been identified that the generic SMR-300 presents opportunities for long-term social value benefits, examples might include:

- The provision of long-term, stable work leading to enhancement of the local economy, over multiple generations throughout construction, operational and decommissioning stages of the project.
- The operator has the opportunity to manage and enhance nearby greenspace as part of its long-term BNG strategy (necessary for site-specific consenting). Enhanced natural spaces can provide ecosystem services, as well as improved habitats for ecology.
- The provision of apprenticeship and school-engagement activities, leading to upskilling of local workforce.

4.10.4 Summary of Sustainability

Sustainable development has been embedded into the generic SMR-300 design through the development of the environmental policy and the Sustainability Strategy. These documents will serve as a basis for future sustainability risk and opportunity identification as the generic SMR-300 project progresses through design, construction and commissioning, operation and decommissioning. The Sustainability Strategy will be updated for a site-specific project to ensure its scope takes into account local stakeholders and site-specific factors (see Table 8: Future Evidence, CIA_14).

The delivery of SMR technology contributes to sustainable development for the UK, increased resilience in the national energy network, and delivery of cleaner energy.

4.11 FUTURE EVIDENCE

Beyond GDA timescale, the management of conventional environmental assessments will continue to develop in line with the evolving maturity of the SMR-300, as well as the requirements of environment permits and consents. Therefore, an indicative list of future work to be undertaken as 'Future Evidence' is provided in Table 8.

Table 8: Future Evidence

[REDACTED]

4.12 SUMMARY

Throughout the development of this two-step GDA process, key environmental issues and risks have been identified as being present in the generic SMR-300 design, relevant to the sub-topics as outlined in the GDA guidelines.

Much of the work conducted in the production of key supporting documents during Step 2 have used information from other new build designs, including the Holtec SMR-160 design and the Holtec Palisades SMR-300 design. Future work has been identified and will be required in order to maintain compliance with UK environmental legislation in relation to water abstraction, water discharges, combustion activities, COMAH regulations and equipment using F-gas and ODS. Therefore, this work has been essential in providing the foundation for future environmental protection work. In general, no major issues or concerns have been identified at this early stage of the generic SMR-300, and this will carefully reassessed as the design progresses.

Water abstraction rates are expected to be approximately 2,375m^3 per hour, which is comparable to other SMR technology, particularly when calculated on a per Megawatt (MW) basis. Based on these abstraction rates the generic SMR-300 will require an abstraction licence, if the plant is located on a freshwater site.

The main effluent waste streams have been identified throughout the generic SMR-300. It is known that water will be treated and dosed with a variety of chemicals, and these are typical of PWRs in the industry. Exact volumes and dosing regimes depend on the water quality input to the systems in which that water will be used, however it is known that treatment prior to discharge will take place to ensure water quality discharged from the generic SMR-300 is within acceptable limits. This is also true of thermal properties of the discharge. Conditions for discharges will be agreed with the relevant authorities during the siting process and will include limits on discharge effluent properties (chemical and thermal).

Cooling technology of the plant is assumed to be MDCT technology, which advantageously utilises less water than a once-through cooling system, however the cooling technology is subject to future design optioneering. Design optioneering will take into account industry best practice, guidance and relevant BREF documentation as applicable, as well as balancing safety, security, resource availability, environmental impact and cost considerations.

Combustion plant in the generic SMR-300 will primarily comprise standby generators (most likely diesel) and an auxiliary boiler (likely diesel, but possibly natural gas). A baseline estimate of the efficiencies of these systems indicates that the total MW_{th} input for the site will be approximately 46.86MW_{th}. This is within the MCPD thresholds (1MW_{th} to 50MW_{th}), however, given the uncertainties surrounding this estimate and the fact that combustion plant design is liable to change, it is prudent to assume that the generic SMR-300 could fall within the IED regulations (>50MW_{th}). Future assessments conducted at site-specific stage will eliminate this uncertainty. It is known that the generic SMR-300 will need to obtain a GHG Emissions Permit in line with the GHG Emissions Trading Scheme because combustion plant will be higher than 20MW_{th}.

A range of chemicals will be stored or used on site which could be subject to COMAH requirements under COMAH15. Of those identified, only hydrazine is estimated to be present on site in amounts greater than at least the lower threshold for COMAH. This means that, at a minimum, the generic SMR-300 is likely to be a lower tier COMAH establishment. It is possible that future design development will mean more hydrazine is used or stored than estimated, therefore it is possible the generic SMR-300 may be an upper tier COMAH establishment. Future design work will eliminate uncertainties, and this aspect of regulatory compliance will be monitored carefully, from an environmental protection perspective as well as from a personnel safety perspective.

Finally, equipment using F-gases has been identified in the generic SMR-300 design documents in fire protection systems, chillers and refrigeration units, and HVAC systems. The type of F-gas to be used is subject to future design development and thorough consultation of banned F-gases at the time of operation will influence design options. No ODS are planned to be used in the generic SMR-300. Holtec Britain and future operators of the SMR-300 recognise the responsibility to ensure effective management and maintenance of equipment containing F-gases in accordance with UK legislation.

There are requirements on the licensee and operator of the generic SMR-300 to demonstrate compliance with environmental regulations and sustainability requirements, which will be considered during the future design stages so that the design can be optimised for environmental protection and sustainable development. Development of environmental policies including the early iteration of an environmental management plan and action registers ensures that the protection and mitigation processes are carried through from this stage of the project to the next.

In particular, the Sustainability Strategy which has been developed alongside the work conducted in this GDA sets out Holtec Britain’s intentions with ensuring the generic SMR-300 project not only meets environmental obligations, but looks more broadly to all aspects of sustainability including, but not limited to, carbon accounting, climate change adaptation and resilience, circular economic principles, long term lifecycle impacts of the plant (particularly in relation to waste management), efficient natural resource management, social value and community impacts, and more. As design progresses, commitments and requirements which have been captured and recorded in the work conducted to date will embed environmental protection as design develops.

Future work conducted in the environmental impact assessment space will be based on the early conclusions found in this report, working to close out uncertainties and obtaining the relevant permits and licences as needed. The future evidence identified throughout the development of this CIA chapter will help to embed environmental protection and sustainability in future design development, construction, operation and decommissioning of the generic SMR-300.

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