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3.1 DEFINITIONS AND ABBREVIATIONS

Table 1: List of Abbreviations and Definitions

Term	Definition
A	Argument
ADMS	Atmospheric Dispersion Modelling System
ALARA	As Low As Reasonably Achievable
ALARP	As Low As Reasonably Practicable
Ar	Argon
BAT	Best Available Techniques
Bq	Becquerel
BSO	Basic Safety Objective
BSS	Basic Safety Standards
BSSD	Basic Safety Standards Directive
C	Carbon
CAR	Commitments, Assumptions, Requirements
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
Cs	Caesium
CES	Containment Enclosure Structure
DECC	Department of Energy and Climate Change
DEFRA	Department of Environment, Food & Rural Affairs
DPUC	Dose Per Unit Concentration
DPUR	Dose Per Unit Release
DRP	Design Reference Point
EA	Environment Agency
EC	European Commission
EPR	European Pressurised Reactor
EPR16	Environmental Permitting (England and Wales) Regulations 2016
ERICA	Environmental Risk from Ionising Contaminants: Assessment and Management
EU	European Union
EURATOM	European Atomic Energy Community
FASSET	Framework for the Assessment of Environmental Impact
FRED	FASSET Radiation Effects Database
GBN	Great British Nuclear
GDA	Generic Design Assessment
GDP	Generic Developed Principles
GN	Guidance Note
GSD	Generic Site Description
GSE	Generic Site Envelope
Gy	Gray
H	Hydrogen
HI-STORM	Holtec International Storage Module
HLW	High Level Waste
HPA	Health Protection Agency
HPR	Hualong One Pressurised Reactor
I	Iodine
IAEA	International Atomic Energy Agency

Term	Definition
ICRP	International Commission on Radiological Protection
ICRU	International Commission on Radiation Units and Measurements
ILW	Intermediate Level Waste
IRAT2	Initial Radiological Assessment Tool 2
IRR17	Ionising Radiations Regulations 2017
ISFSI	Independent Spent Fuel Storage Installation
Kr	Krypton
MPC	Multi-Purpose Canister
NDAWG	National Dose Assessment Working Group
NFW	Non-Fuel Waste
NFWC	Non-Fuel Waste Canister
NRPB	National Radiological Protection Board
ONR	Office for Nuclear Regulation
OPEX	Operating Experience
PC-CREAM 08	Consequences of Releases to the Environment Assessment Methodology 2008 computer code
PER	Preliminary Environmental Report
PGIRE	Practitioner Group on the Impact of Radioactivity in the Environment
PHE	Public Health England
PRISM	Product Safety Risk Assessment Methodology
PSR	Preliminary Safety Report
PWR	Pressurised Water Reactor
RAB	Reactor Auxiliary Building
RCLEA	The Radioactively Contaminated Land Exposure Assessment methodology
REPPIR19	Radiation (Emergency Preparedness and Public Information) Regulations 2019
RI	Regulatory Issue
RIA	Radiological Impact Assessment
RIFE	Radioactivity in Food and the Environment
RO	Regulatory Observation
RP	Requesting Party
RSR	Radioactive Substances Regulations
SA	Sub-argument
SAP	Safety Assessment Principles
SDG	Sustainable Development Goals
SFP	Spent Fuel Pool
SMR	Small Modular Reactor
SONGS	San Onofre Nuclear Generating Site
SSEC	Safety, Security and Environment Case
SSSI	Sites of Special Scientific Interest
Sv	Sieverts
SZB	Sizewell B
TRIF	Tritium Transfer Into Food
UK	United Kingdom
UKHSA	United Kingdom Health Security Agency
UMAX	Underground Maximum Security
US NRC	United States Nuclear Regulatory Commission
Xe	Xenon

Term	Definition
Yo	Year old

3.2 INTRODUCTION

This report comprises Chapter 3 – Radiological Impact Assessment (RIA) of the Holtec generic Small Modular Reactor (SMR)-300 Preliminary Environmental Report (PER). The PER forms part of the Generic Design Assessment (GDA) for the generic SMR-300.

As a Nuclear Power Plant (NPP), the generic SMR-300 will discharge radionuclides into the environment throughout its lifetime. Discharged radionuclides will result in exposure to wider populations than those present within the nuclear plant site. Assessment of the impact of these discharges is carried out using a staged approach, as recommended in the Environment Agencies Principles for the Assessment of Prospective Public Doses arising from Authorised Discharges of Radioactive Waste to the Environment [1], typically consisting of:

- Stage 1, the initial scoping assessment, utilising simple and cautious assumptions considering the impacts on representative members of the public, and wildlife from continuous discharges and direct radiation.
- Stage 2, a refined assessment, utilising more realistic data for the site, but maintaining simple and cautious assumptions.
- Stage 3, a detailed source and site assessment; this is a further refined assessment using increasingly realistic parameter assumptions for the sources, site and receptors. The Stage 3 assessment must also assess: the impact of short-term releases on local populations to determine the acceptability of any proposed short-term release limits, and doses to population groups (collective doses) for each of the discharge routes. The assessment may also consider other sources on the site – for example adjacent nuclear facilities.

This report considers the impact of discharges of radionuclides to the environment and direct radiation resulting from the operation of a twin unit generic SMR-300 reactor site, and the doses that could result, in relevant population groups and wildlife. Stages 1 and 2 of the assessment approach have been completed as is proportionate for a fundamental assessment for Step 2 of the GDA. The impact assessments in this report are performed for the design of the generic SMR-300 at the GDA Design Reference Point [2] (DRP).

The Stage 1 and 2 assessments are derived using The Initial Radiological Assessment Tool version 2 (IRAT2) calculation spreadsheets provided by the Environment Agency (EA) in the following:

- Initial Radiological Assessment Tool 2: Part 1 User Guide [3].
- Initial Radiological Assessment Tool 2: Part 2 Methods and Input Data, Chief Scientists Group Report [4].
- Initial Radiological Assessment Tool 2: Summary [5].
- Initial Radiological Assessment Tool - Air [6].
- Initial Radiological Assessment Tool - River [7].
- Initial Radiological Assessment Tool - Sewer [8].
- Initial Radiological Assessment Tool - Estuary coast [9].

This report introduces the future Stage 3 RIAs which will be carried out at later design stages, and for each specific site selected for the deployment of one or more SMR-300 twin reactor units. The site-specific assessments consider more realistic site and receptor assumptions and expands the remit to include assessment of collective dose, an assessment of impact of short duration elevated effluent discharges, and an assessment of impact of the build-up of radionuclides on prospective future users of the site and its vicinity after power operations cease.

Assessed doses are compared against Ionising Radiations Regulations 2017 (IRR17) [10] and Environmental Permitting (England and Wales) Regulations 2016 (as amended) (EPR16) dose legal limits [11], and dose constraints set by the EA [1] and generic SMR-300 design standards [12].

This approach to RIA is consistent with the approach taken across all other GDAs at Step 2 and proportionate to the requirement for a fundamental assessment in a 2-Step GDA.

3.2.1 Purpose

This chapter provides the methods, input data and fundamental assessment results of RIA of radioactive aqueous and gaseous effluent discharges from the generic SMR-300 site. It demonstrates that the doses from effluent discharges to any population and wildlife will be As Low As Reasonably Achievable (ALARA) and in line with EA guidance [1] and IRR17 constraints and limits [10]. These assessments will aid in the demonstration that the design of the generic SMR-300 can represent Best Available Techniques (BAT).

3.2.2 Scope

The central scope for this GDA RIA is to produce the following:

- Assessment of exposure to public exposure groups from routine aqueous and gaseous effluent discharges.
- Assessment of exposure to wildlife from routine aqueous and gaseous effluent discharges.
- Comparison of results against proposed limits and legal constraints.
- Sensitivity analysis of input parameters and results, especially for the definition of the generic site.
- Development of methodologies and identification of data needs for site-specific assessments.

Assessment of discharges during / following accident conditions, during commissioning or during decommissioning are excluded from the scope of this GDA. Additionally, the radiological impact of on-site and off-site transport of radioactive wastes and new fuel is outside of the scope of this report.

Aqueous wastes include waste that is dissolved in water and excludes oils and residues. Gaseous wastes include gases and airborne particulates.

The effluent management routes from generation to discharge and disposal of aqueous and gaseous wastes, quantification of aqueous and gaseous waste and in PER Chapter 6 Demonstration of Best Available Techniques [13] for radioactive waste management are outside of the scope of this chapter; however, this chapter will provide supporting arguments to claims related to these topic areas.

This document covers the assumptions and representative information for calculating doses to members of the public and dose rates to non-human species from aqueous and gaseous discharges during operation[1] of the generic SMR-300 using the IRAT2 methodology, together with presentation and discussion of results, and comparison against limits and constraints.

The following variables and their impact on activity concentration and receptor dose are considered in defining the generic site, and form part of the sensitivity analysis:

- Stack height.
- Radionuclides and discharge limits.
- Relative position of stack(s).
- Sea water flows between local and regional waters (the volumetric exchange rate).

Note that any onsite incinerators would also be assessed at this stage; however, the SMR-300 design has ruled out having an onsite incinerator, therefore, this assessment is not required.

The assessment of impact of direct radiation on members of the public is provided in the Dose Management Strategy [14], a supporting document to Revision 1 of Preliminary Safety Report (PSR) Part B Chapter 10 [15], and in Holtec SMR-300 Radiological Impact Assessment Topic Report [16]. The results of the direct radiation assessment are summed with those for effluent discharges to provide the total dose estimate to the representative (most exposed) members of the public for the site. As per International Commission on Radiation Protection (ICRP) Publication 101 [17] "*for the purpose of protection of the public, it is necessary to characterise an individual, either hypothetical or specific, whose dose can be used for determining compliance with the relevant dose constraint. This individual is defined as the 'representative person'.*"

3.2.3 Chapter Structure

This chapter is structured to provide information required for a meaningful 2-Step GDA assessment. The main structure of this chapter consists of:

- Sub-chapter 3.2 introduces the purpose, scope, interfaces and assumptions for RIAs and BAT arguments relevant to this chapter.
- Sub-chapter 3.3 presents the regulatory context, such as regulatory expectations and requirements, Radioactive Substances Regulations (RSR) principles, codes and standards considered for RIA.
- Sub-chapter 3.4 presents the background to RIA including the staged assessment process and the level of detail required in input parameters at each stage; the discharge source term used for assessments and the Generic Site Description (GSD), which provides input parameters for the assessments.
- Sub-chapter 3.5 presents the methods for and results from the Stage 1 and 2 assessment of radiological impacts on candidate representative persons and wildlife of continuous aqueous and gaseous discharges at a coastal site.
- Sub-chapter 3.6 summarises the impact assessment of direct radiation on members of the public as provided in the Dose Management Strategy [14] and RIA Topic Report [16].

[1] Any radioactive discharges during commissioning or decommissioning of the generic SMR-300 are not included within the scope of this chapter. These assessments will be completed as part of site-specific permitting applications.

- Sub-chapter 3.7 provides total dose estimates for the representative person for the site, who would receive the highest dose from all activities onsite (aqueous and gaseous effluent discharges and direct radiation).
- Sub-chapter 3.8 provides the methodologies for Stage 3 assessments to be conducted at the pre-construction and site-specific stage.
- Sub-chapter 3.9 provides a summary of the sensitivity analysis of input parameters.
- Sub-chapter 3.10 summarises this chapter.
- Sub-chapter 3.11 sets out GDA Commitments and future evidence relevant to the RIA topic area.
- Sub-chapter 3.12 provides the references for this chapter.

3.2.4 Interfaces with Other Chapters

To define the interfaces between this chapter and other chapters in the Safety, Security and Environment Case (SSEC) in order to demonstrate that the environment case in this chapter works together with them to form an overall strategic environment case, this is detailed in Table 2 below.

Table 2: Interfaces with Other SSEC Chapters

Chapter Title	Interface
PER Chapter 1 Radioactive Waste Management Arrangements [18]	PER Chapter 1 presents the management arrangements for solid, liquid and gaseous radioactive waste arising over the lifecycle of the generic SMR-300, providing detail in how the effluents will be generated.
PER Chapter 2 Quantification of Effluent Discharges and Limits [19]	PER Chapter 2 provides the source term for these assessments. Initial radiological assessments conducted in the RIA Topic Report [16] were utilised in Chapter 2 to identify significant radionuclides to include in assessments and a future permit. A GDA Commitment is raised in Chapter 2, C_QEDL_100, to determine transient phase discharge source terms (i.e. source terms for plant start-up and shutdown, maintenance and testing, load following and expected events) once discharge schedules and process-specific source terms are available. These source terms will allow the short-term discharge RIA to be conducted.
PER Chapter 4 Conventional Impact Assessment [20]	PER Chapter 4 considers the non-radiological environmental impacts of the generic SMR-300. The RIA provides the developed GSD used by both.
PER Chapter 5 Monitoring and Sampling [21]	PER Chapter 5 sets out parameters to be monitored and the arrangements in place for the generic SMR-300 based on significant radionuclides proposed in PER Chapter 2 [19].
PER Chapter 6 Demonstration of Best Available Techniques [13]	PER Chapter 6 demonstrates that the generic SMR-300 design utilises BAT and is optimised so that the generation and disposal of radioactive waste will be prevented and minimised to reduce the impact on the members of the public and environment to ALARA. PER Chapter 6 [13] contains the following radiological impact assessment BAT Claim: **Claim 4.4: Impacts of Radioactive Wastes** *The impacts of radioactive wastes including discharges and disposals from the generic SMR-300 have been minimised. Radiation doses to any individual member of the public and the population as a whole are as low as reasonably achievable. Non-human species are adequately protected against exposures to ionising radiation.* The Claim and associated Arguments and Sub-Arguments are presented in the PER Chapter 6 [13] to give an overview of the evidence presented in this chapter to support the BAT demonstration for the generic SMR-300.
PSR Part A Chapter 1 Introduction [22]	PSR Part A Chapter 1 provides the information required of the GDA, and the structure of the PER, which this chapter follows.
PSR Part A Chapter 2 General Design Aspects and Site Characteristics [23]	PSR Part A Chapter 2 provides the general design aspects and defines the Generic Site Envelope (GSE) used throughout the SSEC. This chapter expands the GSD to include sensitivity analysis of these assumptions with respect to radiological impacts and confirms the bounding nature of the assumptions.
PSR Part B Chapter 10 Radiological Protection [15]	PSR Part B Chapter 10 aims to provide information on source terms and dose rates for direct radiation exposure to members of the public. Where generic SMR-300 specific data is not available, this will be supplemented with Operational Experience (OPEX) from similar facilities, taking cognisance of the site layout.

Chapter Title	Interface
PSR Part B Chapter 13 Radioactive Waste Management [24]	PSR Part B Chapter 13 describes the design and operation of the radioactive waste facilities. Correct operation of these facilities will ensure that discharges are minimised. Demonstration that the design of these facilities optimises the balance between discharges and generation of solid radioactive wastes will be presented within the BAT chapter.
PSR Part B Chapter 14 Design Basis Analysis (Fault Studies) [25]	PSR Part B Chapter 14 presents the deterministic analysis for the SMR-300 following accident conditions and presents the basis for demonstration that the risk is As Low As Reasonably Practicable (ALARP) in comparison with the numerical targets introduced in PSR Part A Chapter 2 [23]. Future iterations of Chapter 14 will support the derivation of transient source terms to be used to derive short-term discharges in PER Chapter 2 [19]. This will inform the short-term discharge RIA methodology and assessment.
PSR Part B Chapter 23 Reactor Chemistry [26]	PSR Part B Chapter 23 describes the reactor chemistry, and the design decisions made to minimise the source term in support of the demonstration that risks are reduced to ALARP. The outcome of the RIA will feed back into Chapter 23 to either support the ALARP argument or point to further measures required to reduce source terms.

3.2.5 Assumptions

The following assumptions are made to underly the development of the RIA methodologies, this also considers the 'Base Case' in the Funded Decommissioning Programme [27]:

- The GSD for the generic SMR-300 is as presented in the GSE Report [28].
- The operational lifetime of a generic SMR-300 is 80 years. Assessment of impacts to the public and the environment for this fundamental assessment will be made at year 50, due to the limitations of the IRAT2 models. The impact of this assumption is addressed as part of the sensitivity analysis in sub-chapter 3.9.
- The assessments also assume that the exposure groups (human and wildlife) do not change substantively throughout the reactor lifetime.
- A single point of discharge is assumed for gaseous discharges.[2]

Additional assessment specific assumptions are discussed in the relevant sub-chapters for each methodology. Note that the habits that are relevant today, as assumed in the assessments covered in this document, are likely to be very different to habits following 80 years of operation. Through a combination of climate change, dietary changes in effort to reduce carbon footprints, consumption trends, working activities, and leisure activities, habits are expected to be quite different to those exhibited today. It is vital, therefore, that conservatisms are included in assessments.

[2] This will result in a conservative dose uptake estimate, as there would be a higher degree of dilution and dispersion of effluent from multiple discharge points. The current design intent is to discharge the majority of gaseous wastes from a stack associated with one reactor unit, with the remainder from a second stack associated with the other reactor unit. Therefore, at this stage, it is not an overly pessimistic assumption.

3.3 REGULATORY CONTEXT

3.3.1 GDA Requirements

To guide the development of the environment case for a NPP in the United Kingdom (UK), Generic Design Assessment Guidance for Requesting Parties [29] details the information required for environment case for the whole GDA process including the information related to RIA. This is summarised in Table 3 below, together with how this will be addressed within the PER and shortfalls in meeting the regulatory requirements at this current design stage.

Table 3: Summary of GDA Requirements Supporting and Information to be Produced

GDA Requirement for Step 2 Assessment	Information as Part of GDA
The Requesting Party (RP) must provide a radiological assessment of proposed limits for:	
• Annual dose to most exposed members of the public for liquid discharges. • Annual dose to most exposed members of the public for gaseous discharges (separately identify the dose associated with on-site incineration where applicable). • Annual dose to the most exposed members of the public for all discharges from the facility.	Sub-chapter 3.5 provides information on the methodologies for assessing annual doses to members of the public from aqueous and gaseous discharges as applicable for a 2-Step GDA, based on the discharge limits defined in Revision 1 of PER Chapter 2 [19]. These methods have been developed utilising two GSDs as described in the GSE Report [28]. The results of the dose assessments are provided in sub-chapter 3.5 for the coastal reactor siting scenario. Further refined assessments will be required once a stack height has been identified at the site-specific stage.
Annual dose from direct radiation to the most exposed members of the public.	Dose Management Strategy [14] provides information in support of assessment of direct radiation doses to most exposed members of the public, the methodology and assessment results are presented in the RIA Topic Report [16] and summarised in sub-chapter 3.6. As the facility layout is developed and detailed shielding and dose assessment is completed at the site-specific stage, further assessments will be required to ensure direct radiation doses are ALARP.
Annual dose to the representative person for the facility.	Annual dose to the representative person for the facility has been assessed for the coastal siting scenario and is presented in sub-chapter 3.7. The assessment will be refined at later design stages and the site-specific stage.
Potential short-term doses, including via the food chain, based on the maximum anticipated short-term discharges from the facility in normal operation.	Short-term dose assessment requires more input information than is available at this stage. The point of this assessment is to determine the impact of proposed short-term discharge limits; however, transient source terms and discharges following expected events have not yet been established in PER Chapter 2 [19]. A commitment has been raised in PER Chapter 2 to identify these source terms [19]. Methods for assessing short-term discharges have been derived and are presented in sub-chapter 3.8.3. Assessment of short-term releases will be developed as site operations and source terms are established.
A comparison of the calculated doses with the relevant dose constraints.	A comparison of calculated doses will be carried out against dose limits, targets and constraints, where dose assessments have been possible, these are presented in sub-chapter 3.5. Full assessment will be carried out for future design iterations once a site has been identified.
An assessment of whether the build-up of radionuclides in the local environment of the facility, based on the anticipated lifetime discharges, might have the potential to prejudice the activities of other legitimate users or uses of the land or sea.	Methods for assessing whether build-up of radionuclides will affect future users of the site are presented in sub-chapter 3.8.5, to support assessments carried out at the site-specific stage.
Collective dose truncated at 500 years to the UK, European and world populations.	Collective dose assessment cannot be completed within the GDA as siting of the facility within the UK needs to be defined. The method for assessing collective dose is presented in sub-chapter 3.8.2. Collective dose assessments will be completed at the site-specific stage.

GDA Requirement for Step 2 Assessment	Information as Part of GDA
The Requesting Party (RP) must provide a radiological assessment of proposed limits for:	
Dose-rate to non-human species.	The methods and results for screening dose assessments to representative non-human species for aqueous and gaseous discharges are presented in sub-chapter 3.5. Detailed assessments for habitats and specific species within or in close proximity to the site will be assessed at the site-specific stage.

3.3.2 Radioactive Substances Regulations Principles

The RSR Objective and Principles [30] set out the regulatory principles applied by the EA as set out in EPR16 [11] and government policy. These are supported by a set of RSR Generic Developed Principles (GDPs), which lay out the EA's expectations on radioactive substances permit holders:

- Regulatory Guidance Series RSR 1: Radioactive Substances Regulation – Environmental Principles (Version 2) [31].
- Guidance: Management and leadership for the environment: GDPs [32].
- Guidance: Radioactive substances management: GDPs [33].
- Guidance: Site evaluation: GDPs [34].
- Guidance: Engineering: GDPs [35].
- Guidance: Radiological protection of people and the environment: GDPs [36].

The key RSR principles and GDPs that are taken into account and complied with when developing the RIA of discharges on population groups and wildlife are presented in Table 4 below.

Table 4: RSR Principles Relevant to RIA

RSR Principle	Information as Part of GDA
Principle 3: dose limitation *Radiation doses to the public from radioactive substances activities must be kept within statutory dose limits.*	PER Chapter 3 presents the methods for assessing radiation doses to members of the public, together with listing all relevant statutory limits. Assessment of doses to representative persons has carried out in this report and will be further refined at the site-specific stage.
Principle 4: protecting wildlife *Radioactive substances activities must not cause wildlife to be exposed to levels of ionising radiation that would have adverse consequences for ecosystems, designated conservation sites and protected species.*	PER Chapter 3 presents the assessment methods and results for radiation dose rates to a range of reference organisms, additionally a comparison against screening values is presented.
RSMDP12: Limits and levels on discharges *Limits and levels should be established on the quantities of radioactivity that can be discharged into the environment where these are necessary to secure proper protection of human health and the environment.*	PER Chapter 2 [19] presents the limits for effluents proposed to be discharged by the generic SMR-300. Initial assessment of whether proper protection is achieved will be carried out and detailed assessments will be considered at the site-specific stage.
RPDP1: Optimisation of protection *All exposures to ionising radiation of any member of the public and of the population as a whole shall be kept as low as reasonably achievable (ALARA), economic and social factors being taken into account.*	PER Chapter 3 links to the claim in PER Chapter 6 [13] and provides key dose information and insight to radiological impacts for consideration in BAT arguments The Approach and Application to the Demonstration of BAT [37] establishes the methodology for demonstration of BAT during GDA. Implementation of BAT should drive the design to achieve exposures that are ALARA.

RSR Principle	Information as Part of GDA
RPDP2: Dose limits and constraints *Radiation doses to individual people shall be below the relevant dose limits and in general should be below the relevant constraints*	PER Chapter 3 presents the methods for assessing radiation doses to members of the public and the doses calculated, together with listing all relevant statutory limits, targets and constraints. Assessed doses are compared against limits and constraints. Detailed assessments considering short-term discharges will be considered at the site-specific stage.
RPDP3: Protection of non-human species *Non-human species should be adequately protected from exposure to ionising radiation.*	PER Chapter 3 presents the methods for assessing radiation dose rates to a range of reference organisms, together with assessment of dose rates and comparison against screening values.
RPDP4: Prospective dose assessments *Assessments of potential doses to people and to non-human species should be made prior to granting any new or revised permit for the discharge of radioactive wastes into the environment.*	PER Chapter 3 presents the methods for assessing exposures to people and non-human species based on discharges at proposed permit levels. Detailed assessments of exposures will be carried out at the site-specific stage.
SEDP1: General principle for siting of new facilities *When evaluating sites for a new facility, account should be taken of the factors that might affect the protection of people and the environment from radiological hazards and the generation of radioactive waste.*	The GSD, within the GSE provides high level factors that have been considered to complete this GDA. Site characterisation, including geology, hydrogeology, meteorology, topography, soil science, marine parameters, habits and habitats etc. will need to be made at the site-specific stage.
SEDP2: migration of radioactive material in the environment *Data should be provided to allow the assessment of rates and patterns of migration of radioactive materials in the air and the aquatic and terrestrial environments around sites.*	PER Chapter 3 details data requirements to complete future assessments in Consequences of Releases to the Environment Assessment Methodology 2008 computer code (PC-CREAM 08). Generation of data will be made at the site-specific stage.
DEDP4 – Discharges during decommissioning *Aerial or liquid radioactive discharges to the environment during decommissioning should be kept to the minimum consistent with the decommissioning strategy for the site.*	Data on discharges during decommissioning will not be available during GDA. High level assessments and optimisation of discharges during decommissioning will be completed as part of the site-specific environmental impact assessment.

3.3.3 Other Requirements for Radiological Impact Assessments

3.3.3.1 International Context

The system of radiation protection that is used worldwide is based upon the recommendations of the ICRP and the International Commission on Radiation Units and Measurements (ICRU). This system is based upon three fundamental principles: justification, optimisation, and dose limitation as written The 2007 Recommendations of the International Commission on Radiological Protection, Annals of the ICRP, vol. 37 no. 2-4 [38].

The International Atomic Energy Agency (IAEA) Basic Safety Standards (BSS) are widely adopted as the foundation for national legislation. Their purpose is to safeguard workers, patients, the public, and the environment from the risks associated with ionising radiation. Schedule III.3 sets for public exposures an effective dose limit of 1000 µSv y^{-1}. The European Commission (EC) Directive 2013/59/European Atomic Energy Community (EURATOM) (Basic Safety Standards Directive (BSSD)) [39] is based upon the IAEA BSS and brings the international standards into European law. EPR16 [11], IRR17 [10] and the Radiation (Emergency Preparedness and Public Information) Regulations 2019 (REPPIR19) [40] all stem from this directive.

The IAEA BSS extends protections beyond worker, patient and public exposures to radiation, to protection of the environment, explicitly stating that protection of the environment includes the protection and conservation of non-human species and their biodiversity. No exposure limits for non-human species are defined in the BSS.

Within Europe, the EC fifth framework project FASSET (Framework for the Assessment of Environmental Impact) created a framework for the assessment of impacts on the environment. The FASSET Radiation Effects Database (FRED) database was created within this project, with its main use to gather literature data to help summarise dose-effect relationships between radiation exposures and their effects on organisms. A further deliverable from this piece of work was the Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) project, where a tool for the assessment of exposures to a range of reference organisms was created. Within this tool, screening values were provided based upon international research into radiation effects on biota (including data entered into the FREDERICA database).

3.3.3.2 Regulation in England and Wales

Schedule 23 of EPR16 [11] regulates discharges of radioactive substances to the environment. Part 4 Section 1 specifies the following with regards to optimisation and dose limits:

1. In respect of a radioactive substances activity that relates to radioactive waste, the regulator must exercise its relevant functions to ensure that—
    a) All exposures to ionising radiation of any member of the public and of the population as a whole resulting from the disposal of radioactive waste are kept as low as reasonably achievable, taking into account economic and social factors, and
    b) The sum of the doses resulting from the exposure of any member of the public to ionising radiation does not exceed the dose limits set out in Article 13 of the BSSD subject to the exclusions set out in Article 6(4) of that Directive. Specific dose limits and calculation.
2. (1) In exercising those relevant functions in relation to the planning stage of radiation protection, the regulator must have regard to the following maximum doses to individuals which may result from a defined source—
    a) 0.3 millisieverts per year from any source from which radioactive discharges are first made on or after 13th May 2000, or
    b) 0.5 millisieverts per year from the discharges from any single site.

The 1000 μSv y^{-1} dose limit in EPR16 implements the BSS / BSSD requirements for protection of members of the public from exposure to ionising radiation. The dose constraint requirements are implemented through Schedule 23(2), restricting the dose to individuals from single sources and sites. The Health Protection Agency (HPA) (now the United Kingdom Health Security Agency, (UKHSA)) recommended in Application of the 2007 Recommendations of the ICRP to the UK: Advice from the HPA [41] a dose constraint of 150 μSv y^{-1} for new nuclear power stations, on the basis of uncertainties in health effects in response to the ICRP 2007 recommendations [38]. This recommendation has not been incorporated within any regulation or guidance. A UK government Review of Radioactive Waste Policy, Cm2919 [42] set a threshold of optimisation for exposure to members of the public from radioactive waste of 20 μSv y^{-1}, equating to a risk of death of approximately 1 in 10^6, as being broadly acceptable and in line with Target 3 of Office for Nuclear Regulation (ONR) Safety Assessment Principles (SAPs) for Nuclear Facilities, 2014 Edition Revision 1, i.e. the Basic Safety Objective (BSO) for public exposures [43].

Statutory Guidance was issued from the Department of Energy and Climate Change (DECC) to the EA [44]. This guidance recommends: provided that the holder of a permit continues to apply BAT, the EA should not seek to further reduce any discharge limits in place, for sources of radiation where the dose to the most exposed member of the public is below 10 μSv y^{-1}.

The Principles for the Assessment of Prospective Public Doses arising from Authorised Discharges of Radioactive Waste to the Environment [1] is a document produced by all UK environment agencies and provides the basis for assessment of public exposures. This document introduces trivial dose and states that average annual individual doses in the nSv y^{-1} range or below should be ignored in the decision-making process, as associated risks are miniscule, and up to a few μSv y^{-1} can be considered trivial. Calculated doses in excess of this however, should prompt careful consideration of the discharge options. This document also summarises radiological protection criteria for public exposures and provides 13 dose principles.

Radiological protection criteria for public exposure relevant to future discharges and direct radiation are summarised in Table 5. The dose principles that apply in the radiological assessment at this stage of GDA are presented in Table 6, together with a discussion on how these are addressed at GDA.

Table 5: Radiological Protection Criteria for Public Exposures Related to Prospective Discharges and Direct Radiation

Criteria	Quantity μSv y^{-1}	Doses to be included in assessments against criteria			
		Source of radiation for the site		Other sources of radiation (excluding medical and natural)	
		Future Discharges	Future Direct Radiation	Future Discharges	Future Direct Radiation
Dose limit (effective dose) [10]	1000	✓	✓	✓	✓
Dose limit for the skin (equivalent dose) [10]	50,000 averaged over any area of 1 cm^2	✓		✓	
Dose limit for the lens of the eye (equivalent dose) [10]	15,000	✓		✓	
Site Dose Constraint (effective dose) [11]	500	✓			
Source Constraint (effective dose) [11]	300	✓	✓		
Investigation level for generalised derived constraint	100	✓			
Threshold of optimisation (effective dose) [42]	20	✓	✓		
Potentially of no regulatory concern (effective dose) [44] [45] [46]	<10	✓	✓		

Table 6: Environment Agency Principles for Assessing Prospective Dose

Dose Principle	How it is addressed in this document
1 - *Prospective dose assessment methods, data and results should be transparent and made publicly available.*	PER Chapter 3 provides the methods, data and results for prospective dose assessment.
2 – *When determining discharge permits or authorisations, the dose to the representative person should be assessed.*	Holtec SMR-300 Radiological Impact Assessment Topic Report [16] provides the method for determining significant radionuclides relating to dose to individuals, populations and wildlife. Radionuclides determined to be significant based on dose, have been considered in PER Chapter 2 [19] for the purpose of consolidating a list of significant radionuclides to be included in a future site permit.
3 - *Doses to the most affected age group should be assessed to determine discharge permits or authorisations. Assessment of doses to 1 year olds, 10 year olds and adults (and foetus, when appropriate) is adequate age group coverage*	Doses are assessed for all age groups listed in Dose Principle 3.
4 - *The dose to the representative person which is assessed for comparison with the source constraint and, if appropriate, the site constraint, should include all reasonably foreseeable and relevant future exposure pathways.*	The exposure pathways and habits considered at this stage are appropriate for a fundamental assessment. Requirements for addressing exposures to representative persons for a Stage 3 assessment are discussed within this document, including the definition of exposure pathways.
5 - *Where a cautious estimate of the dose to the representative person exceeds 20 µSv y^{-1}, the assessments should be refined and, where appropriate, more realistic assumptions made. However, sufficient caution should be retained in assessments to provide confidence that actual doses received by the representative person will be below the dose limit*	This fundamental assessment considers Stage 1 (scoping) and refined Stage 2 (fundamental) assessments. It also provides the methodology for completing further refined, more realistic, assessment, to be completed at a later date.
6 - *The assessment of dose to the representative person should take account of accumulation of radionuclides in the environment from future discharges*	This fundamental assessment assesses the dose to the representative person following 50 years of discharge, as incorporated into IRAT2 [3] [4] which considers the accumulation of radionuclides over a 50-year period. Additionally, the sensitivity analysis presented in sub-chapter 3.9 considers the impact of 50-year versus 80-year discharge period for the fundamental assessment. Stage 3 assessments will assess the dose at year 80. Site-specific assessment will also take into consideration the accumulation of radionuclides from other sources on, or adjacent to, the site.
9 - *Where the assessed mean dose to the representative person exceeds 20 µSv y^{-1}, the uncertainty and variability in the main assumptions used for the dose assessment should be reviewed.*	Sensitivity analysis for the derivation of the GSD has been completed. Further analysis of the impact of assumptions around habits has been completed.

Assessment of potential impact on non-human species is a GDA requirement [29], and will be a consideration for future site permits as detailed in How to apply for an environmental permit Part RSR-B3 – New bespoke radioactive substances activity permit nuclear site – unsealed sources and radioactive waste; Guidance notes [47] and Criteria for setting limits on the discharge of radioactive waste from nuclear sites [48]. In generic developed principle RPDP-3 presented in Guidance: Radiological protection of people and the environment: GDPs [36] (see Table 4), the EA considers that there will be no adverse effects at population level to reference species below a guideline dose level of 40 µGy h^{-1}. A more restrictive screening level of 1 µGy h^{-1} is used within IRAT2 [3] [4] to determine whether a refined dose assessment is required.

3.3.3.3 UK Guidance on Radiological Assessments

Further guidance on radiological assessments is provided by UK competent bodies including the UKHSA (previously Public Health England (PHE), HPA and National Radiological Protection Board (NRPB)), the National Dose Assessment Working Group (NDAWG) and its successor, the Practitioner Group on the Impact of Radioactivity in the Environment (PGIRE).

NDAWG reports and guidance form UK relevant good practice for the assessment of radiological impacts of discharges on members of the public. The NDAWG reports and guidance that will inform RIAs and comparisons are listed here.

NDAWG reports:

- Short duration releases to atmosphere [49].
- Short term releases to rivers [50].
- Acquisition and use of habits data for prospective assessments [51].
- Overview of radiological assessment models - key gaps and uncertainties [52].
- Methods for assessment of total dose in Radioactivity in Food and the Environment (RIFE) reports [53].
- An overview of uncertainty in radiological assessments [54].
- Radiological assessment exposure pathways checklist (common and unusual) [55].
- Use of measurements in assessing doses to the public [56].

NDAWG Guidance Notes (GN):

- GN 7 Use of habits data in Prospective Dose Assessments [57].
- GN 6B Short term release assessments. Updated June 2020 [58].
- GN 5 The estimation and use of results on exposure to direct radiation [59].
- GN 4 Considering uncertainty and variability in radiological assessments [60].
- GN 3 Exposure pathways [61].
- GN 2 Initial / simple assessment tools [62].
- GN 1 Assessment of radiation doses from routine discharges of radionuclides to the environment [63].

UKHSA and predecessor documents that will inform assessments include:

- The methodology for assessing the radiological consequences of routine releases of radionuclides to the environment used in PC-CREAM 08 [64].
- Assessment of dose rates to Biota in PC-CREAM 08 [65].
- Guidance on the assessment of radiation doses to members of the public due to the operation of nuclear installations under normal conditions [66].
- Generalised Habit Data for Radiological Assessment [67].
- Methodology for estimating the doses to members of the public from the future use of land previously contaminated with radioactivity [68].
- Atmospheric dispersion from releases in the vicinity of buildings [69].
- A methodology for assessing doses from short-term planned discharges [70].
- Contaminated Land guidance documents:
    - Risks from land contaminated with radioactivity [71].
    - Principles for assessing risks from land contaminated with radioactivity [72].
    - Application of the planning regime for radioactivity in the ground: Wales [73].
    - Application of the radioactive contaminated land regime: Wales [74].

- Application of the radioactive contaminated land regime: England [75].
- Application of the planning regime for radioactivity in the ground: England [76].
- Guidance on remedial actions for land contaminated with radioactivity [77].
- FAQ: Land contaminated with radioactivity [78].

3.3.4 Demonstration of Best Available Techniques

The RIA will support the claim that the impact of radioactive discharges and releases on the public and the environment is ALARA. Demonstration that doses to members of the public and the environment are trivial (and ALARA) can assist in arguing that the design and operation of the reactor utilises BAT throughout. Achieving doses to representative persons below the threshold for optimisation, and especially the 'below regulatory concern' (see Table 5) values can be considered indicators for BAT. Radiological impact and dispersion assessments will be carried out at the site-specific stage to optimise the dispersion of discharges, through assessment of stack height with respect to the site (layout, topography, meteorological conditions etc.) and optimisation of aqueous discharge point (captured as Future Evidence, see RIA_01 in Table 28 and further discussed in sub-chapter 3.9.3).

3.3.5 Sustainability

In line with the requirements in The UK Policy Framework for Managing Radioactive Substances and Nuclear Decommissioning [79], the development of RIAs should consider internationally recognised best practices in sustainability, specifically the United Nations Sustainable Development Goals (SDG) [80], which aim to protect the environment and the current and future generations. The overall sustainability approach for the generic SMR-300 is detailed in Holtec SMR-300 GDA Sustainability Strategy [81].

In the development of the environment case in the generic SMR-300 GDA process, application of the waste hierarchy and a risk-informed approach are recognised as key principles in the lifecycle of radioactive waste management, which ensure that the radioactive wastes, including those discharged from the site are managed in a safe, secure, environmental, and sustainable approach. The main aspects from the RIA perspective that contribute to sustainable development in the generic SMR-300 include:

- BAT will be used to inform the deployment of the generic SMR-300 in the UK as well as applying the waste hierarchy principles to prevent and / or minimise the impacts of radioactive discharges on the public and environment. Holtec SMR-300 GDA RSR-BAT Guidance [82] supports the implementation of these aspects in the management of the design.
- In the optimisation process of radioactive effluent discharges (and solid radioactive wastes generated through the filtration of the effluents), all relevant competing factors, such as safety, technical feasibility, environment, and socio-economic benefits, etc., will be considered appropriately to give a single solution through the risk-informed decision-making approach.
- Managing the waste as soon as practicable considering all the relevant factors such as the availability of resources (people, supply chain, funding, waste management infrastructure). This chapter will assess the buildup of radioactive materials in the vicinity of the reactor site which will provide the input data to support the remediation and decommissioning planning post operation.

3.4 RADIOLOGICAL ASSESSMENT OF THE GENERIC SMR-300

3.4.1 Background to Radiological Impact Assessments

The overall approach to assessing the radiological impacts of routine discharges of gaseous and aqueous radioactive effluents from the generic SMR-300 to the environment is based on the staged approach advocated by NDAWG in NDAWG Guidance Note 2 [62] and in the EA Principles for the Assessment of Prospective Public Doses [1]. The staged approach comprises three tiers of radiological assessments, characterised by increasing level of detail and complexity. Figure 1 below presents the staged approach to dose assessment, based on IRAT2: Part 1 User Guide [3].

The EA have produced an initial radiological assessment methodology to support operators and inspectors in assessing radiological impacts from routine radiological discharges. The EA Initial Radiological Assessment Methodology 2 [3], [4], [5], and associated tool IRAT2, provide Dose Per Unit Release (DPUR) values for radioactive discharges to air [6], marine / estuarine [9], river [7] and sewer [8] environments. This methodology is detailed in sub-chapter 3.5 and addresses Stages 1 and 2 and will be used for the assessment of the radiological impact of discharges at the coastal site.

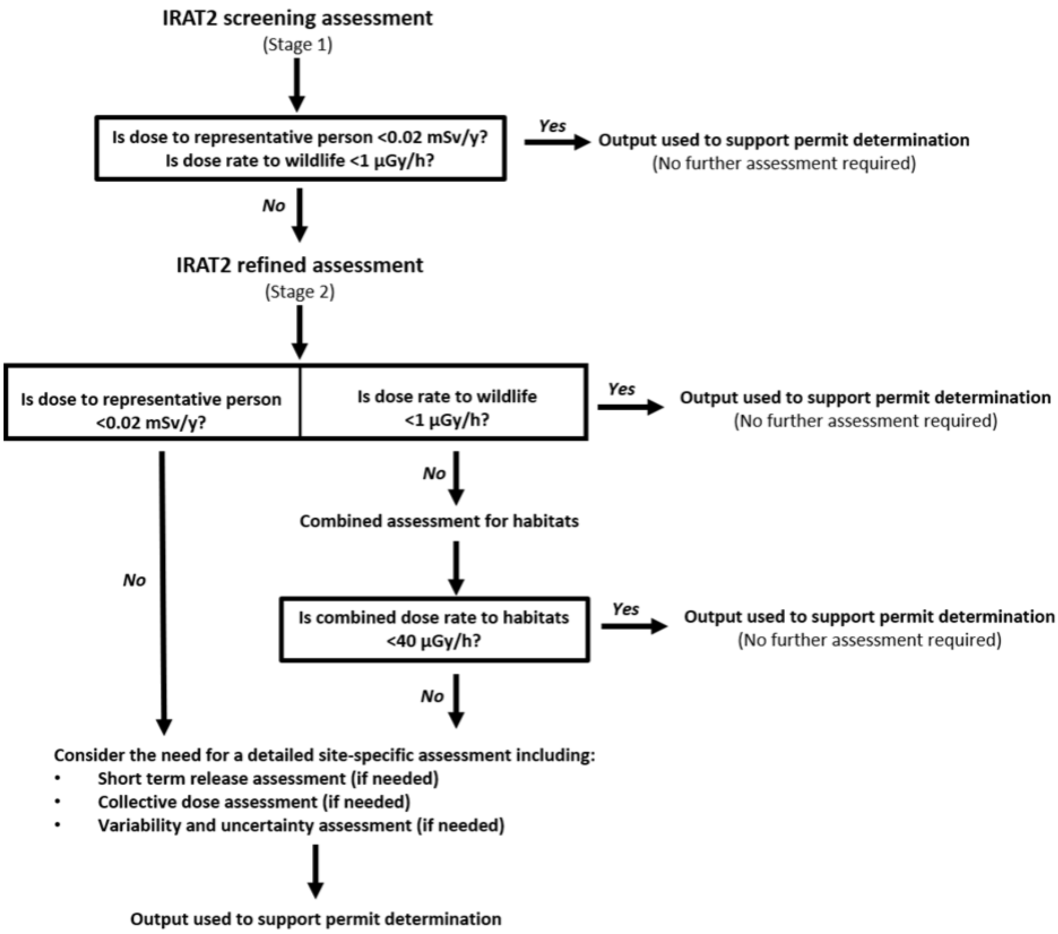

Figure 1: Stages of EA Dose Assessment Process Used When Permitting Discharges of Radioactive Effluents

Stage 1 of IRAT2 is a scoping calculation, carried out using default values which are deemed to be cautious and should bound the majority of UK based discharges. Should doses to the representative person and wildlife not exceed 20 μSv y^{-1} and 1 μGy h^{-1} respectively, using this cautious method, then no further assessment is required.

Stage 2 of IRAT2 is a fundamental assessment and requires the user to input more realistic site parameters to scale the doses to model site parameters more accurately. If dose to the representative groups still exceeds the set constraints of 20 μSv y^{-1} and 1 μGy h^{-1} to the representative person and wildlife respectively, then a Stage 3 detailed assessment is required.

Stage 3 involves the use of detailed modelling methods to more accurately assess the build-up and distribution of radioactivity through the environment, and the habits of local populations.

Within this Step 2 GDA, Stage 1 and 2 assessments will be completed, and methodologies to complete Stage 3 assessments will be introduced.

For a two-step GDA there is insufficient data available to complete a detailed Stage 3 assessment, especially given the design maturity. Stage 1 and 2 assessments are provided here and discussion of parameter requirements to allow a Stage 3 assessment to be completed is provided in sub-chapter 3.8.

Note that throughout the report, when discussing results, all doses will be presented to one significant figure, as there are input parameters only accurate to this level within this fundamental assessment. In tables, however, individual results are presented to two significant figures purely to allow summation and show the dose breakdown.

3.4.2 Source Term

Radiological assessments have been completed using the annual gaseous and aqueous discharge limits as discussed in PER Chapter 2 [19].

Selection of significant radionuclides is covered by PER Chapter 2 [19] which provides a comprehensive list of all significant radionuclides for aqueous and gaseous discharges from the generic SMR-300. Selection of significant radionuclides related to dose (as per criteria in EA guidance 'Criteria for setting limits on the discharge of radioactive waste from nuclear sites' [48]) is covered in the RIA Topic Report [16] and considered in PER Chapter 2 [19] in order to consolidate the list of significant radionuclides to be included in a future site permit.

Tables presenting dose assessment results in this chapter only list the radionuclides which will be present in the permit, as per PER Chapter 2 [19].

All aqueous waste will be discharged through a single release point which will be designed such that the discharge readily disperses within the receiving water body. The design of plant stacks, the release points for gaseous waste, is currently under development and parameters necessary for the RIA – number of stacks, stack height, the bearing and distance between stacks, and the radionuclide distribution between the stacks – are unavailable. As per sub-chapter 3.2.5, it is conservatively assumed all gaseous waste is discharged through a single release point, which will lead to lowest dispersion and provide bounding dose estimates.

3.4.3 Generic Site Description

3.4.3.1 Introduction

To meet the GDA requirements listed in Table 3, the RIA must assess the impact from a site that is suitably representative of a potential future Holtec SMR-300 nuclear power plant. At this stage, no site been selected for a generic SMR-300 in the UK. Therefore, a generic site must be defined.

The GSE is defined in the GSE Report [28]. The site characteristics defined in the GSE and presented in this sub-chapter will ensure impact assessments of future discharges are realistically bounding. The GSE covers three broad areas: external hazards, natural or man-made hazards external to the facility which may affect the operation of the facility; Generic Site Information, including features of a site that can be defined on a qualitative basis; and, the GSD, including the features and characteristics of a site required to enable an assessment of the radiological and conventional impacts of the generic SMR-300 on people and the environment.

Two prospective future siting scenarios were identified in the GSD for the generic SMR-300: a coastal site discharging into a marine environment and an inland lakeside site discharging into a lake. Llyn Trawsfynydd had been considered by the UK Government to be a candidate site for a future NPP; However, during the progression of this GDA, Great British Nuclear

(GBN) has discounted the Trawsfynydd site as a potential site for the initial SMR rollout phase due to the size of the site and volume of cooling water. Instead focussing on the EN-6: National Policy Statement for nuclear power generation [83]. A fundamental assessment of radiological impact at the lakeside site was carried out in the RIA Topic Report [16]; however, as a result of the pessimisms in the assumptions and C-14 discharge quantities it was not possible to demonstrate that doses resulting from aqueous discharges into Llyn Trawsfynydd would be acceptable for the generic SMR-300, or in fact any Pressurised Water Reactor (PWR), without significant additional abatement for C-14[3]. Sensitivity analysis demonstrated that discharges into larger lake systems with a significantly higher volume and river flow rate, could result in doses below the source dose constraint. Owing to the above reasons, discharges into a lakeside site is not considered further in the PER; therefore, only discharges at a coastal site are presented in this report.

3.4.3.2 Generic Coastal Site Description

The generic coastal site is defined in detail in the GSE Report [28], the key site parameters are listed below. More detail on exposed groups, exposure pathways and habits are provided in sub-chapter 3.5 and the RIA Topic Report [16].

- The site is coastal.
- The topography of the site is flat or will be engineered to be so.
- Discharge routes are assumed to be gaseous aerial discharges and aqueous discharges to the coastal environment.
- Atmospheric discharges are made from a single release point.
- The height of any atmospheric discharges is cautiously assumed to be at ground level, with an effective stack height of 1 m.[4] [5]
- Marine discharges are made from a single release point, within the local marine compartment.
- The volumetric exchange rate in the local marine compartment is 100 $m^3 s^{-1}$.
- Secondary cooling is achieved through the use of draft cooling towers.[6]

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[3] This aligns with the operation of the Magnox reactor at Trawsfynydd which underwent additional abatement of the aqueous wastes prior to discharge into the Llyn as stated in the Trawsfynydd Site Strategic Environmental Assessment Site Specific Baseline [112].

[4] The plant stack design is currently under development and there is insufficient information regarding stack height, exhaust gas flow velocities, exhaust gas temperature and the height and position of surrounding buildings to accurately estimate the effective release height. Hence, the stack is conservatively assumed to be ground level, giving an effective gaseous effluent release height of 1 m. A significant portion of the Containment Enclosure Structure (CES) and the Reactor Auxiliary Building (RAB) will be below ground level, therefore the overall height of the building and the minimum height of the plant stack is unlikely to be as high as for traditional reactor designs. The impact of stack height on dose is discussed further in sub-chapters 3.5.3.2.2 and 3.9.3.2.

[5] Radiological impact and dispersion assessments will be Future Evidence to be provided at the site-specific stage to support the optimisation of discharge dispersion as part of BAT studies. This will be performed through assessments of stack height with respect to the site (layout, topography, meteorological conditions etc.). This item of Future Evidence is provided in Table 28, RIA_01.

[6] Technical assumptions have been made in PER Chapter 4 [20] that the cooling system design is based on cooling tower technology. This does not preclude the design from opting for other cooling

- No incinerator is planned to be built on site.
- There is no water extraction from aquifers and no standing water at the site.
- There are no planned releases to groundwater and no freshwater bodies are on or adjacent to the site.

technologies during site-specific design, An optioneering study will be completed at the site-specific stage.

3.5 RADIOLOGICAL IMPACT OF CONTINUOUS DISCHARGES AT A COASTAL SITE

3.5.1 Method

The purpose and scope of the initial radiological assessment methodology, IRAT2 Part 1 [3], Part 2 [4] and Summary [5], are to provide a system for undertaking an initial cautious prospective assessment of the dose arising from radioactive waste discharges to the environment, and to identify those discharges for which a more detailed assessment should be undertaken. It should be noted that this methodology is generic for any radiological practice.

The assessment consists of three stages. At the first stage (Stage 1), default values are used in IRAT2. Proposed discharge limits are input, as presented in PER Chapter 2 [19], and calculated doses to individuals and non-human species are presented in the tool.

A Stage 2 assessment uses refined data which is more suited to the site in question. The GSD within GSE Report [28], summarised in PSR Part A Chapter 2 [23] provides the parameter values for a Stage 2 IRAT2 assessment.

IRAT2 provides robust and acceptable screening to identify where further resource should be expended to review radioactive effluent discharge quantities and facility design to ensure impacts on members of the public and non-human species are ALARA. Simple cautious assumptions are made regarding the behaviour of radionuclides in the environment and the habits of persons possibly exposed.

In IRAT2, all discharges are assumed to be continuous (for a period of 50 years), uniform, routine releases. Effective dose is calculated based on an integration time of 50 years. Therefore, for a reactor facility with a longer planned operating lifetime, IRAT2 will underestimate the build-up of radioactivity in the biosphere, especially for radionuclides with a long half-life (such as Cs-137) and properties that result in the radioactivity being retained close to the soil surface. A Stage 3 assessment would therefore be required to fully account for this discrepancy. However, due to the conservatisms inbuilt within IRAT, it is not unreasonable to assume that the data is still sufficiently conservative to adequately cover impacts following 80 years of discharges at this stage. The impact of reactor lifetime on the dose assessment is further discussed in the sensitivity analysis in sub-chapter 3.9.2.2.

IRAT2 calculates the dose to the worst affected individuals by multiplying the predicted discharge rates by DPUR factors (μSv y^{-1} per Bq y^{-1}). DPUR factors are provided for many radionuclides (including all key nuclear activation and fission products), internal and external exposure pathways, and four age groups (adult, child, infant and offspring). IRAT2 consists of separate models for each of the four discharge routes. Dose data is presented as a summary value for each radionuclide broken down by exposure pathway, based on the bounding DPUR value across the four age groups.

IRAT2 is capable of providing a screening dose assessment for a range of wildlife reference organisms utilising the same input data as for public exposures. The reference organisms in IRAT2 are taken from the lists of reference organisms in D-ERICA: An integrated approach to the assessment and management of environmental risks from ionising radiation. Description of purpose, methodology and application [84] and the associated ERICA tool [85], which are replicated in Table 11.

DPUR values for wildlife presented in IRAT2 for marine and aerial discharges have been generated using Dose Per Unit Concentration (DPUC) data calculated in the ERICA tool [84] [85]. The ERICA tool does not incorporate assessment methods and tools for noble gases; instead, the Ar-Kr-Xe dose calculator for wildlife dose assessment [86], a spreadsheet-based tool, was used to derive DPUC factors for noble gas radionuclides used in IRAT2.

3.5.1.1 Stage 1 and Stage 2 Assessments

The GSD [28] provides parameter values to enable a Stage 2 RIA to be completed for the coastal generic site. The site is modelled as a UK coastal or estuarine location, with low dispersion to the wider marine environment. Atmospheric and marine discharges are modelled using IRAT2.

The GSD [28] provides parameter values to enable a Stage 2 RIA to be completed for a coastal site scenario, noting that as the design of the generic SMR-300 ventilation systems, and stack discharges are not sufficiently mature to enable derivation of an effective stack height for gaseous discharges. At this stage, a ground level release has been assumed for gaseous discharges at both Stage 1 and 2. A commitment has been raised, as presented in sub-chapter 3.5.3.2.2, to complete a revised Stage 2 assessment once potential stack heights and relative positions have been determined. The impact of this assumption is discussed in 3.5.3.2.2 and 3.9.3.2. Selected Stage 1 and 2 user editable parameters utilised in IRAT2 Air and Marine models, as defined in the GSD [28], are presented in Table 7 below.

Table 7: Summary of Stage 1 and Stage 2 IRAT2 Input Parameters

IRAT 2	Air Model		Marine Model	
Stage	**Parameter**	**Value**	**Parameter**	**Value**
1	Stack Height	0 m	Volumetric Exchange Rate	30 m^3/s
2		0 m		100 m^3/s

Detailed parameters characterising the local marine compartment, as assumed in IRAT2: Part 1 [3] and IRAT2: Part 2 [4] in generating the DPUR values, are presented in Table 8 below for Stage 2 assessment.

Table 8: Local Marine Compartment Characteristics (Stage 2)

Parameter	Value
Volume	10^8 m^3
Depth	10 m
Coastline length	10 km
Volumetric exchange rate	100 m^3/s
Suspended sediment load	10^{-5} t/m^3
Sedimentation rate	4.9 10^{-3} $t/m^2/y$
Density of dry sediment particles	2.6 t/m^3
Diffusion rate (sediment diffusion coefficient)	3.15 10^{-2} m^2/y

3.5.2 Representative Groups

As presented in Table 3, the aim of the RIA is to determine the radiological impact of discharges to the most exposed persons for each of the discharge routes, and to then assess to dose to the representative person for the site. The representative person is the individual who is representative of the most highly exposed persons for the site as a result of their living environment and habits.

Four age groups are considered: foetus (or offspring), 1-year old infants, 10-year-old children and adults. The DPUR for the most exposed age group for each discharged radionuclide is presented in IRAT2. The exposed adults may receive a proportion of their exposure whilst working, for example farming or fishing. Assumptions in IRAT2 [3] [4] regarding occupancy and food consumption are all bounding based on information provided in NRPB-W41, Generalised Habit Data for Radiological Assessment [67].

3.5.2.1 Representative Group for Aqueous Discharges

For discharges to the marine environment, the exposure group considered is a 'fishing family'. Members of this group are assumed to be exposed to radioactivity in coastal discharges through consumption of seafood contaminated by radionuclides in seawater and spending time on local beaches. This group is assumed to be career fishers, with adults conservatively spending 2000 hours per year fishing on the local beach. resulting in maximum exposure to external gamma in beach sediments whilst working. Children are assumed to spend 300 hours per year on the beach performing recreational activities such as playing or dog walking. Infants do not visit the beach independently for recreational activities and are only assumed to spend 30 hours per year on the beach. The exposure pathways for this group are as follows:

- Internal radiation from the consumption of seafood contaminated with radionuclides.
- External radiation from radionuclides in beach and shore sediment.

Exposure to contaminated fishing gear, inhalation of sea spray and suspended sediment and inadvertent ingestion of seawater were not included in the assessment as doses from these pathways are insignificant in comparison to the two assessed pathways.

3.5.2.1.1 Parameters and Assumptions

Habit data assumed in IRAT 2 [3] [4] for the fishing family is presented in Table 9 below. Fish, crustaceans and molluscs are caught and consumed at representative critical group rates as per Generalised Habit Data [67]. All crustaceans and molluscs are assumed to be caught locally: 50% of fish are caught in the local compartment and the remainder in the regional compartment as per IRAT2: Part 2 [4].

Table 9: Habit Data for Fishing Family

Parameter	Infant	Child	Adult	Fraction in compartment	
				Local	Regional
Food Consumption rates (kg/y)					
Fish	5	20	100	0.5	0.5
Crustaceans	0	5	20	1	0
Molluscs	0	5	20	1	0
Occupancy on beach (h/y)	30	300	2000	1	0

3.5.2.2 Representative Group for Gaseous Discharges

For discharges to air, the exposure group considered is the 'local resident family'. Members of this group are assumed to be exposed to a plume of radionuclides discharged to the atmosphere and the deposition of a portion of that discharge on the ground, resulting in exposure to external radiation and through the consumption of contaminated foods. It is assumed that the group live 100 m from the source; are exposed to the plume and deposited radionuclides at this distance and consume contaminated food grown at a distance of 500 m from the source as per IRAT2: Part 2 [4]. The exposure pathways for this group are as follows:

- Internal radiation from the inhalation of radionuclides in the effluent plume.
- External radiation from radionuclides in the effluent plume.
- External radiation from radionuclides deposited to the ground.
- Internal radiation from consumption of terrestrial food containing radionuclides deposited to the ground (not considered for radionuclides with half-lives <3 hours).

3.5.2.2.1 Parameters and Assumptions

Habit data for the resident family is presented Table D.1 in IRAT 2 [4] and is replicated in Table 10 below. The adults are assumed to be farmers, spending 50% of their time outdoors. Their annualised breathing rates consider periods of activity, rest and sleep, this is deemed to be appropriate for assessing exposures to members of the public for extended periods of time[7]. All food intake rates are very conservatively taken to be the 97.5th percentile rate of consumers from Generalised Habit Data [67]. It is assumed that the group live 100 m from the source and have been exposed to inhalation and external radiation at this distance and consume contaminated food grown at a distance of 500 m from the source [4]. As the effective stack height is at 1m, the peak ground level activity concentration will occur at 100 m from the discharge point [87]. As there is insufficient space at this distance to produce all foods for the family, it is assumed in IRAT2 that they are produced 500 m away.[8]

Table 10: Habit Data for Resident Family

Parameter	Infant	Child	Adult
Food Consumption Rates (kg/y)			
Green vegetables	15	35	89
Root Vegetables	45	95	130
Fruit	35	50	75
Sheep meat	3	10	25
Sheep liver	2.75	5	10
Cow meat	10	30	45
Cow liver	2.75	5	10
Cow milk	320	240	240
Breathing rates (m^3/h)	0.22	0.64	0.92

[7] Note, for a Stage 3 assessment, more bounding breathing rates may be considered appropriate for adults should their habits demonstrate they spend extended periods of time conducting light and heavy exercise. Stage 3 assessment may consider exposures at multiple distances if working close to the site.

[8] For future prospective dose assessments, once stacks have been specified, the distance at which peak ground level activity concentration occurs should be determined, this distance would then be considered for assessment of a candidate most exposed person.

Parameter	Infant	Child	Adult
Occupancy at habitation (h/y)	8760	8760	8760
Fraction of time spent indoors	0.9	0.8	0.5
Cloud shielding factor (indoors)	0.2	0.2	0.2
Shielding factor for deposited radionuclides	0.1	0.1	0.1
Distance from Stack – dwelling (m) [28]	100	100	100
Distance from stack – food production (m) [28]	500	500	500

3.5.2.3 Representative Group for All Discharges

Assessment of the representative group for all discharges should consider several scenarios, taking into account habits and pastimes of individuals that may become exposed to radionuclides from both gaseous and aqueous discharges. Such habits may include consumption of both locally grown foods and locally caught seafood; living close to the site and regularly spending time at the beach; living on a houseboat close to the site, etc.

3.5.2.3.1 Parameters and Assumptions

For the Stage 1 and 2 assessments, the bounding assessment assumes that the local resident and the fishing family are the same group. The total dose to the representative group from all discharges is therefore the sum of both.

It is reasonable to assume that individuals living close to the site, in a coastal location will also spend a period of time on the beach each year. In addition, it is reasonable to assume that they consume locally caught seafoods. They are unlikely however to spend 2000 hours per year on the beach, nor consume seafoods at critical group[9] intake rates stated in Generalised Habit Data [67] in addition to consuming all terrestrial foodstuffs at 97.5th percentile rates. The assessment is therefore overly conservative and more realistic assumptions would be made to assess the representative persons for all discharges in a Stage 3 assessment.

3.5.2.4 Wildlife

In lieu of a defined habitat, IRAT 2 assesses exposures to a set of reference organisms as applicable to terrestrial, freshwater and marine environments [85]. The reference organisms relevant to the coastal generic site and the doses they receive are included in the RIA.

IRAT 2 Calculates doses to wildlife using the ERICA method as discussed in sub-chapter 3.5.1.

3.5.2.4.1 Parameters and Assumptions

In the absence of a specific site, this assessment is carried out for a generic SMR-300 located at the generic coastal site described in the GSD [28]. For the generic coastal site, it is assumed that all reference organism non-human species, relevant to terrestrial and marine

[9] According to ICRP in publication 101a [110], the 'representative person' is an individual receiving a dose that is representative of the more highly exposed individuals in the population. This term is the equivalent of, and replaces, 'average member of the critical group' described in previous ICRP recommendations. NRPB-W41, Generalised Habit Data for Radiological Assessment [67], was published before this publication, and therefore uses the term critical group.

environments are present. These organisms, replicated in Table 11 below, are taken from the ERICA list of reference organisms [84].

Table 11: Reference Organisms Assumed for Coastal Wildlife Impact Assessments

Terrestrial Reference Organisms	Marine Reference Organisms
Amphibian	Benthic fish
Annelid	Bird
Arthropod - detritivorous	Crustacean
Bird	Macroalgae
Flying insect	Mammal
Grasses and herbs	Mollusc - bivalve
Lichen and bryophytes	Pelagic fish
Mammal - large	Phytoplankton
Mammal - small burrowing	Polychaete worm
Mollusc - gastropod	Reptile
Reptile	Sea anemone and true corals
Shrub	Vascular plant
Tree	Zooplankton

3.5.3 Assessment of Dose and Discussion

3.5.3.1 Annual Dose to Most Exposed Persons for Aqueous Discharges

3.5.3.1.1 Stage 1

A Stage 1 assessment has been completed for the coastal generic site, where a bounding volumetric exchange rate of 30 m^3 s^{-1} was assumed.

The total dose to the fishing family from aqueous discharges from a twin unit generic SMR-300 facility into the local marine compartment was calculated to be [REDACTED]. The results for the generic SMR-300 and are broken down by radionuclide and exposure pathway in Table 12 below. This dose was dominated by ingestion of C-14 in seafood, accounting for 99% of the dose.

Table 12: Dose to Representative Groups, Aqueous Marine Discharges – Stage 1

[REDACTED]

3.5.3.1.2 Stage 2

A refined, Stage 2, assessment has been completed for the coastal generic site using the IRAT 2 Estuary / coast tool [9], assuming a volumetric exchange rate of 100 $m^3 s^{-1}$ from the GSE Report [28].

The total dose to the fishing family from aqueous discharges from a twin unit generic SMR-300 facility into the local marine compartment was calculated to be [REDACTED]. A dose breakdown by radionuclide and exposure pathway is presented in Table 13. This dose was dominated by ingestion of C-14 in seafood, accounting for 99% of the dose.

Table 13: Dose to Representative Groups, Aqueous Marine Discharges – Stage 2

[REDACTED]

The dose to the fishing family (all age groups) is dominated by the ingestion pathway which accounts for almost 100% of the dose based on Generalised Habit Data [67] critical group[9] consumption rates for seafoods. C-14 is the dominant radionuclide accounting for almost 100% of the dose. The dose to this group is far below the public dose limit [10] [11] and source constraint of 300 µSv y^{-1} [11] and is below the threshold of optimisation (20 µSv y^{-1}) [42] below which it is not necessary to refine the assessments further. Doses to the fishing family are below the Holtec SMR-300 dose constraint for members of the public [12].

3.5.3.2 Annual Dose to Most Exposed Persons for Gaseous Discharges

3.5.3.2.1 Stage 1

A Stage 1 assessment has been completed for gaseous discharges at the coastal generic site using the IRAT 2 Air tool [6], where a bounding stack height of 0 m, dwelling location of 100 m and food production at 500 m was assumed.

The total dose to the worst age group local resident family from gaseous discharges from a twin unit generic SMR-300 facility was calculated to be [REDACTED]. The summary results for the generic SMR-300 are presented in Table 14 broken down by radionuclide and exposure pathway.

Table 14: Dose to Representative Groups from Gaseous Discharges

[REDACTED]

The dominant pathways for exposures to the local resident family for gaseous discharges are inhalation (55%) and ingestion of foodstuffs (34%) when assuming critical rate consumption of all foodstuffs. The dose to this group is far below the public dose limit in IRR17 [10] and EPR16 [11] and source constraint of 300 μSv y^{-1} in EPR16 [11]. [REDACTED]

3.5.3.2.2 Stage 2

A refined Stage 2 assessment has not been completed at this stage as further information on potential stack height was not available, consistent with the GSD. A GDA Commitment (**C_RIA_126**) is raised to complete a Stage 2 assessment once stack height information becomes available to obtain more realistic dose estimates. The details of the commitment are presented in Table 27 in sub-chapter 3.11.

The assessment completed in this report assumed a ground level release as no further information is currently available. In lieu of a full Stage 2 assessment, preliminary calculations have been completed, based on the above ground height of the CES. According to the General Arrangement of Reactor Auxiliary Building for SMR-300 [88], both CES are approximately 40 m tall, whereas the Reactor Auxiliary Building (RAB) is less than 20 m tall at its highest.

Assuming an effective release height of 10 m (which is approximately equivalent to a stack height of 30 m using the one-third height rule) would reduce the total dose[10] to this group to [REDACTED] (a two-thirds reduction in dose). This would bring the gaseous discharges impact to below the threshold for optimisation [42]. At 10 m, the peak activity concentration remains at 100 m from the stack discharge point [87]. For a 10 m effective stack height, the most significant pathway is ingestion of foodstuffs, accounting for approximately 79% of the dose uptake using the IRAT2 method [6]. Assuming more realistic consumption habits, where a reduced number of foods are consumed at critical rates, would reduce this dose further.

This simple sensitivity analysis demonstrates that a ground level release is not BAT, and that justification for the implementation of a higher stack can readily be made based on the significant reduction in dose for a modest stack height. Determination of an appropriate stack height will be made through BAT assessment and is identified as an item of Future Evidence

[10] Initial radiological assessment methodology 2 (IRAT2) applies a scaling factor for stack heights greater than 0 m. For an effective stack height of 10 m, the scaling factors are 0.1 for inhalation and external exposures, and 0.733 for ingestion of foodstuffs.

to be provided beyond GDA Step 2 (see RIA_01 in Table 28). As dispersion of radioactive gases is impacted by meteorology and topography selection of final stack height will be made for each reactor site.

3.5.3.3 Annual Dose to Most Exposed Persons for All Discharges

The dose to the most exposed persons for all discharges is conservatively assumed to be the sum of dose to most exposed persons for aqueous and gaseous discharges. The total dose to the most exposed persons from all discharges from a coastal twin unit generic SMR-300 facility was calculated to be [REDACTED] assuming a ground level release for gaseous discharges. The summary results for the generic SMR-300 are presented in Table 15 below, broken down by radionuclide and exposure pathway. Due to the approach taken in IRAT2, this total dose is the summation of dose to worst affected age group for each radionuclide and is therefore higher than any one individual dose. Inhalation and ingestion of C-14 and H-3 are the leading routes to exposure, accounting for 90% of the total dose.

Table 15: Dose to Representative Groups from All Discharges at the Coastal Generic Site

[REDACTED]

The dose to the most exposed persons for all discharges of [REDACTED] is far below the public dose limit in IRR17 [10] and EPR16 [11] and source constraint of 300 μSv y^{-1} in EPR16 [11]. [REDACTED]

3.5.3.4 Dose Rate to Wildlife for Aqueous Discharges

The dose rate to wildlife in a marine environment resulting from aqueous discharges to sea has been assessed using IRAT2: estuary coast [9] for Stage 1 and Stage 2 assessments. The total dose rate to the worst affected reference organisms was calculated to be 0.01 μGy h^{-1} and 0.003 μGy h^{-1} for Stage 1 and Stage 2 parameters respectively. Note, due to the way in which IRAT2 assesses doses to reference organisms the total dose is not to a single organism, but across all worst affected organisms per radionuclide. The dose broken down by radionuclide for Stage 1 and Stage 2 is presented below in Table 16 and Table 17 respectively. Dose uptake is dominated by C-14, and the most exposed reference organism is the polychaete worm.

Table 16: Dose Rate to Wildlife, Aqueous Marine Discharges – Stage 1

Radionuclide	Dose Rate (µGy h-1)	Radionuclide Contribution	Worst Affected Reference Organism(s)
H-3	8.0E-05	0.8%	Mollusc – bivalve, Polychaete worm
C-14	8.4E-03	82%	Polychaete worm
Cs-137	2.6E-04	2.6%	Polychaete worm
Other beta / gamma emitting radionuclides	1.5E-03	14.7%	N/A
Total	**0.010**		

Table 17: Dose Rate to Wildlife, Aqueous Marine Discharges – Stage 2

Radionuclide	Dose Rate (µGy h^{-1})	Radionuclide Contribution	Worst Affected Reference Organism(s)
H-3	2.4E-05	0.8%	Mollusc – bivalve, Polychaete worm
C-14	2.5E-03	82%	Polychaete worm
Cs-137	7.9E-05	2.6%	Polychaete worm
Other beta / gamma emitting radionuclides	4.6E-04	14.7%	N/A
Total	**0.0030**		

The dose to all marine wildlife organisms resulting from discharges to the GDA coastal site are below the 40 µGy h^{-1} guideline and the 1 µGy h^{-1} screening level used in IRAT2. Therefore, it is reasonable to assume that radioactive discharges from the SMR-300 do not negatively affect marine wildlife.

3.5.3.5 Dose Rate to Wildlife for Gaseous Discharges

The dose rate to wildlife in a terrestrial environment resulting from gaseous discharges has been assessed using the IRAT2: air tool [6] for the Stage 1 assessment. The total dose rate to the worst affected reference organism was calculated to be 0.1 µGy h^{-1} based on the GSD. Note, due to the way in which IRAT2 assesses doses to reference organisms the total dose is not to a single organism, but across all worst affected organisms. The dose broken down by radionuclide is presented in Table 18 below.

Table 18: Dose Rate to Wildlife, Gaseous Discharges

Radionuclide	Dose Rate (µGy h^{-1})	Radionuclide Contribution	Worst Affected Reference Organism(s)
H-3	7.6E-02	70%	Amphibian, Annelid, Arthropod – detritivorous, Bird, Grasses & Herbs, Mammal – large Mammal - small-burrowing, Mollusc – gastropod, Reptile, Shrub, Tree
C-14	2.8E-02	26%	Bird, Mammal – large, Mammal - small-burrowing, Reptile
I-131	3.0E-08	0.0%	Amphibian

Radionuclide	Dose Rate (μGy h^{-1})	Radionuclide Contribution	Worst Affected Reference Organism(s)
Noble gases	3.0E-03	2.8%	N/A
Other beta-emitting radionuclides associated with particulate matter	7.0E-04	0.6%	N/A
Total	**0.11**		

As there is no common overlap between marine and terrestrial wildlife there will be no combination of exposures from multiple discharges for wildlife at this stage. The dose to terrestrial wildlife does not exceed the 40 μGy h^{-1} guideline or 1 μGy h^{-1} screening level, therefore, it is reasonable to assume that radioactive discharges from the generic SMR-300 do not negatively affect terrestrial wildlife. Refined Stage 2 and 3 assessments are therefore not necessary unless specific organisms are identified at the site that are not sufficiently accounted for within the set of reference organisms.

3.5.3.6 Discussion

As a result of the bounding assumptions used to conduct the Stage 1 assessment, the dose to candidate representative persons for gaseous discharges, and the most exposed persons for all discharges exceed the threshold for optimisation; a refined, Stage 2 or 3 assessment is necessary. A GDA Commitment (**C_RIA_126**) has been raised for a Stage 2 assessment to be completed once the number, height and relative positions of gaseous discharge points for the site is known.

A Stage 3 assessment should then be completed if doses exceed the threshold for optimisation [1]. Additionally, a Stage 3 RIA will be completed once a site has been selected utilising realistic site and environmental data, see sub-chapter 3.8 for further details. It would be beneficial to consult recent Centre for Environment, Fisheries and Aquaculture Science (CEFAS) habits survey data [89] for the local area if the NPP are to be located adjacent to a site within an existing survey area to compare against national habit data from Generalised Habit Data [90] or similar, to ensure that bounding habits are selected. Several scoping assessments should be completed to ensure that suitably bounding habits are utilised given the long timescales considered for the reactor lifetime.

A Stage 3 assessment should consider the wildlife present in the area, and the potential impacts on flora and fauna that may become exposed to both gaseous and aqueous discharges, this is especially important once a site has been identified and characterised.

3.6 RADIOLOGICAL IMPACT OF DIRECT RADIATION

3.6.1 Preliminary Assessment of Direct Radiation Dose to Members of the Public

In addition to exposures from discharges of radioactive materials, members of the public may be exposed to external radiation emanating from the NPP. The GSD in the GSE Report [28] provides information on exposure parameters for this exposure scenario. External dose rates will be determined fully once the SMR-300 design has progressed sufficiently using appropriate radiation transport codes; however, preliminary analysis has been completed based on the most significant direct radiation sources from the NPP. Direct radiation dose is summed with the calculated discharge doses to establish the total dose from the generic SMR-300 site.

There are several sources of radiation that could result in a dose to members of the public from direct radiation exposure. The core of the reactor, when critical, and the storage of spent fuel and Intermediate Level Waste (ILW) are the most significant sources onsite. Additional, potentially significant, sources of direct radiation to be considered in future assessment include: RAB operations (including primary and secondary circuit); transport of spent fuel across site to the Independent Spent Fuel Storage Installation (ISFSI), and storage of solid High Level Waste (HLW) or ILW such as in-core components[11] [91]. Assessment of the impact of each of these sources will be carried out as part of shielding assessments and ALARP assessment of individual facilities and the site as a whole. These assessments will support future environmental impact assessments at later design stages.

At this current design stage, there is insufficient information to carry out comprehensive assessment of doses; however, a preliminary assessment of the dose received by a local resident family from dry storage of spent fuel in the ISFSI and direct radiation from the reactor cores at power was presented in the RIA Topic Report [16]. A comprehensive direct radiation assessment is identified as an item of Future Evidence to be provided beyond the GDA Step 2 timescale (see RIA_02 in Table 28). It will be carried out once shielding assessment data is available (refined Stage 2 assessment) for a dry spent fuel storage facility containing spent SMR-300 fuel, and secondly once a site has been selected and the site layout is being optimised (Stage 3 assessment) to ensure exposures are both BAT and ALARP.

3.6.1.1 Public Dose Assessment Method

Direct exposure to radiation from the CES for members of the public should be negligible, as the shielding present will ensure contact dose rates for the building are below limits of detection and would not be measurable at the site boundary once shielding is fully designed.

Exposure to direct radiation from storage of waste will give the greatest direct radiation dose for a member of the public. In the UK, assessments of direct radiation are usually carried out

[11] The method for processing and long-term storage of Non-Fuel Waste (NFW) has not yet been finalised; however, a BAT optioneering study identified that the BAT option was to utilise a NFW Container (NFWC), similar to the Multi-Purpose Canister (MPC) used to store spent fuel. The NFWC, along with spent fuel would be stored in the HI-STORM Underground Maximum Security (UMAX) system. Doses from NFWC will be no higher than from MPCs filled with spent fuel, therefore, assessment of a full UMAX system will address public doses from a NFW source.

by monitoring radiation levels at multiple points around the site boundary and at the nearest habitation. Estimates of direct radiation exposure to representative members of the public for existing reactor sites is presented in the annual RIFE reports:

- RIFE-29, 2023 [92];
- RIFE-28, 2022 [93];
- RIFE-27, 2021 [94];
- RIFE-26, 2020 [95];
- RIFE-25, 2019 [96];
- RIFE-24, 2018 [97];
- RIFE-23, 2017 [98];
- RIFE-22, 2016 [99];
- RIFE-21, 2015 [100].

The arrangement for dry storage of spent fuel and storage of ILW will be finalised at the site-specific stage and therefore shielding arrangement and radioactive inventories for each storage facility are not available at GDA. Some simple assumptions have been made to complete a direct radiation assessment.

3.6.1.2 Assessment of Direct Radiation Dose from the Generic SMR-300

At this current design stage, preliminary assessment of direct radiation dose can only be estimated from two sources – direct radiation from generic SMR-300 reactor units at power and from dry spent fuel stored at the onsite ISFSI.

3.6.1.2.1 Direct Radiation from the Reactor at Power

Preliminary assessment of dose rates, out to a distance of 1000 m from the reactor, during the operation of the twin reactors has been calculated in the Shielding Design Basis document [101], using simplified assumptions based on the reactor arrangement at the DRP [2].

- Generic SMR-300 reactor core and irradiated fuel in the Spent Fuel Pool (SFP) are the only sources considered.
- The reactor is simplistically assumed to sit centrally within the Containment Enclosure Structure (CES).
- The concrete well that the Reactor Pressure Vessel sits in and all concrete shielding is standard density concrete.

The results of this preliminary assessment are given in Table 19 below.

Table 19: Direct Radiation Dose Rates to Adult Members of the Public from Reactor at Power

Distance from Centre of Twin Reactors (m)	Dose Rate ($\mu Sv\ h^{-1}$)	Annual Dose Rate ($\mu Sv\ y^{-1}$)
100	$1.5\ 10^{-3}$	13
500	$3.1\ 10^{-5}$	0.27
1000	$2.0\ 10^{-6}$	0.017

3.6.1.2.2 Direct Radiation Dose from Dry Spent Fuel Storage

A GDA scope change proposal paper Reduction in GDA Scope for the HI-STORM UMAX System [102] was raised in Step 2 by the RP to rationalise submissions within the spent fuel management topic area. The change reduced the level of detail of the UMAX System under assessment at GDA, but retained the aspects of both the fuel route and dry storage system within scope to enable a fundamental assessment by the regulators.

The planned UMAX system for the generic SMR-300, and the type, enrichment and burn-up rate of the spent fuel to be stored is sufficiently comparable to existing UMAX systems that OPEX can be used for this preliminary assessment of direct dose to members of the public. OPEX from an above ground storage system, the HI-STORM 100 ISFSI, was included for comparison[12]. Should UK sites implement the HI-STORM 100 system as opposed to the UMAX system, annual doses to members of the public could be higher. Siting of the ISFSI would be very important to ensure public doses were ALARA.

3.6.1.3 Results of Direct Radiation Dose Assessment

A local resident is defined within the GSD [28] as a family spending the whole year in close proximity to the site approximately 100 m from the stack. Utilising the OPEX data for US San Onofre Nuclear Generating Site (SONGS), reproduced in the RIA Topic Report [16], it is possible to estimate the doses to individuals identified in the GSD [28].

Occupancy at the dwelling is given in Table 10 below. The resident family is assumed to live 100 m from the source. The dose rate at 80 m from SONGS ISFSI is taken to be appropriate for this assessment. The dose to members of the resident family from direct exposure, calculated in the preliminary assessment, are given in Table 20 below.

Table 20: Dose to Members of a Local Resident Family from Direct Exposure

[REDACTED]

3.6.1.4 Discussion

Dose to members of the public from direct radiation are compared against the dose limit, source constraint and the threshold for optimisation as shown in Table 5.

Direct radiation dose to members of the public from Sizewell B (SZB) are typically in the range of 1 to 25 μSv y^{-1} as per annual RIFE reports [92] [93] [94] [95] [96] [97] [98] [99] [100]. [REDACTED]

This screening direct radiation dose assessment assumes that the ISFSI is located between the reactor building and the receptor. Typically an ISFSI would be located away from the reactor building, closer to the site perimeter. It is assumed that once a site was selected, the siting of the ISFSI would be optimised such that it would result in the lowest dose impact to both workers and members of the public. It is unlikely that the ISFSI would be located adjacent

[12] The HI-STORM 100 system is installed at Sizewell B and is currently the only spent fuel dry storage system in operation in the UK.

to the site fence close to a permanent residence. It is essential that further refined assessments are carried out, firstly once shielding assessment data is available for a ISFSI containing spent SMR-300 fuel (Stage 2 assessment) and secondly once a site has been selected and the site layout is being optimised (Stage 3 assessment) to ensure exposures are ALARA. Likewise, a similar approach should be taken for the assessment of direct radiation exposures from onsite storage of HLW and ILW.

3.7 ASSESSMENT OF RADIOLOGICAL IMPACT TO THE MOST EXPOSED PERSON FOR THE SITE

The assessment of 'most exposed person' for the site (the representative member of the public who would receive the highest dose from all activities on the site) takes into consideration radiological impact of gaseous and aqueous discharges together with direct radiation exposure. When selecting candidate representative persons for the site the habits and occupancy of prospective individuals need to be taken into consideration. For example:

- Direct radiation is unlikely to be an important pathway for individuals who frequent a beach a few miles from the site; however, they may receive a significant exposure from beach occupancy.
- The location of the nearest dwelling bears a large impact on whether the most exposed person for the site incorporates all pathways.
- An individual working or walking regularly close to the NPP site perimeter may receive a considerable exposure from direct radiation, inhalation and external dose due to cloud and deposited radionuclides, but not consume any locally grown foodstuffs.

Therefore, it is essential that several potential candidate representative groups are identified to determine the representative group for the site, this is especially important for Stage 3 assessments.

3.7.1 Coastal Site

3.7.1.1 Method and Assumptions

For this 2-Step GDA, the representative group for the site is cautiously assumed to be the local resident family for the most exposed persons for all discharges (see sub-chapter 3.5.2.3). As these individuals are assumed to live close to the site, they are also assumed to be exposed to direct radiation from the reactor units and dry spent fuel store.

The dose to the representative group for the coastal generic site is therefore equal to the sum of the dose to most exposed persons for all discharges (see sub-chapter 3.5.2.3) and the direct radiation dose (see sub-chapter 3.6.1).

3.7.1.2 Assessment Results

Total dose to the representative group for the coastal generic site is calculated to be [REDACTED]. This is presented below in Table 21, results are broken down by exposure pathway and Table 22, results are broken down by exposure route. Direct radiation is the biggest source of exposure, accounting for 51% of the total dose, followed by gaseous discharges at 38%. This result assumes a ground level release and the resident family living in close proximity to the site.

Table 21: Total Dose to the Representative Group for the Coastal Generic Site by Exposure Pathway

[REDACTED]

Table 22: Total Dose to Representative Group for Coastal Generic Site by Exposure Route

[REDACTED]

3.7.2 Discussion

[REDACTED]A refined Stage 2 or 3 assessment will be necessary, the Stage 2 assessment should be completed once the number, height and relative positions of gaseous discharge points is known, the layout of the site including position of the ISFSI is defined and shielding analysis has been completed. A Stage 3 assessment is recommended once a site has been selected. It would be beneficial to use recent CEFAS habits survey data [89] for the local environment if the reactors are to be located adjacent to a site within an existing survey area to compare against Generalised Habit Data [67] or similar to ensure that bounding habits are selected for a range of candidate representative persons.

Results of the initial Stage 2 assessment of dose to the most exposed persons for the coastal site are well below the site constraint of 500 μSv y^{-1}, and the source constraint of 300 μSv y^{-1}. [REDACTED]

The assessment in this study is highly conservative, assuming that:

- Members of the public consume all foodstuffs at critical rates, and are all locally sourced.
- Atmospheric discharges from the generic SMR-300 are released at ground level.
- The ISFSI is located in close proximity to the local residents dwelling.
- The most exposed persons are both resident full time and on the coast for 2000 hours.

These, together with other cautious assumptions, including conservatisms in the discharge source term, and summing the worst age group for each radionuclide and pathway result in calculated doses that are far higher than would be achieved in reality.

The assessment presented in this report considered a ground level release, as the design has not yet defined the discharge stacks. For a ground level release, the peak airborne activity concentration (and peak deposition) is at 100 m [87]. Data presented in NRPB-R91 [87] demonstrates that for a 10 m effective release height, the peak time integrated concentration is over a factor of 2 lower, and for a 20 m effective release height the peak time integrated concentration is over a factor of 10 lower and is more than 200 m from the stack (for Stability category D weather conditions). Further commentary on sensitivity analysis for the stack height is presented in sub-chapter 3.9.

As discussed in sub-chapter 3.6.1.4, this assessment conservatively assumes that the ISFSI would be located between the reactor and the receptor. The layout, at the site-specific stage, will be optimised to ensure that the ISFSI is located in a position that minimises exposures to both workers and members of the public are ALARA, taking into account economic and social factors.

Refined assessment, taking into consideration a higher stack and greater source to receptor distance would result in more realistic doses, once the design is more mature, these refined assessments can be completed.

The Holtec HI-STORM UMAX is a modern globally deployed dry spent fuel storage solution which may be applied to other reactor designs in the UK. SZB dry store utilises a Holtec HI-STORM 100 above ground storage design and can achieve offsite annual dose rates below 10 μSv y^{-1} [92], the generic SMR-300 utilising the more advanced HI-STORM UMAX system and should be able to achieve direct radiation dose rates around this level.

The RP has committed to a public dose constraint of 20 μSv y^{-1}, therefore, measures will be taken within the generic SMR-300 design to minimise doses to members of the public through changes to reactor design and optimisation of site layout.

3.8 STAGE 3 RADIOLOGICAL IMPACT ASSESSMENTS

A Stage 3 assessment will be conducted following a Stage 1 screening assessment and Stage 2 refined assessment as outlined in sub-chapter 3.4.1 in Figure 1. A Stage 3 assessment is necessary as earlier assessments presented in sub-chapter 3.5.3 and 3.7 demonstrated that the GSD dose to a representative person is [REDACTED] for the coastal generic site. The Stage 3 assessment will also include collective dose, short-term release and build-up of radionuclides assessments, these are discussed in detail in sub-chapter 3.8.2, 3.8.3, and 3.8.5 respectively. Stage 3 involves defining detailed generic or site-specific parameters which were previously set using conservative and bounding assumptions for the purpose of Stage 1 and Stage 2 assessments. All physical aspects of the local environment (e.g. marine local compartment parameters, meteorological conditions, soil conditions, etc.) will be defined along with receptor characteristics (e.g. occupancy rates, ingestion and inhalation rates, etc.). The parameters required are largely those required to complete an assessment in PC-CREAM [64]. The RIA Topic Report [16] provides tables of input parameters to be established in support of these continuous release assessments for individual and collective doses.

Additional parameters requiring definition are discussed in sub-chapter 3.8.3, and 3.8.5 for short-term discharges and assessment of the impact of build-up of radionuclides respectively. Assessment of the direct radiation impact of the transport of radioactive materials onto and off site will have a different set of parameters which will need to be defined.

Site-specific Stage 3 assessments will estimate doses to members of the public, non-human species and to future users of the site respectively. Detailed site characterisation is to be undertaken at the site-specific stage.

3.8.1 Detailed Site Characterisation

For a Stage 3 assessment it is necessary to determine the characteristics and parameters of the site, the local environment, and receptors in greater detail, which will consist of (non-exhaustive list):

- Researching the habits and habit trends of local residents to identify representative persons with respect to the site.
- Location and identification of non-human reference organisms that inhabit the site vicinity and definition of their respective habitats.
- Determination of meteorological conditions in the vicinity of the site.
- Study and identification of the characteristics of the local environment such as local water sources (including aquifers and water abstraction rates), soil types, topography, geology and local marine environmental conditions for a coastal site.
- Determination of the radiological baseline for the site which includes a review of historic and ongoing discharges.
- Identification of nearby special habitats including Sites of Special Scientific Interest (SSSIs), Ramsar sites etc.

At the site-specific stage a team will be required to conduct desk studies and fieldwork to determine the above site characteristics.

Detailed site characterisation is identified as an item of Future Evidence to be provided beyond the GDA Step 2 timescale, for more detail see RIA_03 in Table 28.

3.8.2 Individual and Collective Doses

3.8.2.1 Introduction to Collective Dose

The atmospheric dispersion of discharged radionuclides results in exposures to populations initially from the first-pass dispersion of the radionuclides from the site and latterly as a result of global circulation. Some radionuclides, owing to their long radioactive half-lives, mobility and their behaviour in the environment, may become globally dispersed and act as a long-term source of irradiation, allowing exposure of wider populations, albeit at much lower levels of individual exposure than to the individuals within the local population. The radionuclides considered in PC-CREAM 08 for global-circulation collective dose are H-3, C-14, Kr-85, and I-129 [64]. Of the radionuclides discharged by the generic SMR-300 design, H-3, C-14 and Kr-85[13] exhibit these characteristics.

Marine dispersion modelling in PC-CREAM 08 takes some account of the global dispersion of radionuclides in the oceans; however, over time, terrestrial pathways for intakes must also be considered within the global model. More information is available in HPA-RPD-058 The Methodology for Assessing the Radiological Consequences of Routine Releases of Radionuclides to the Environment Used in PC-CREAM 08 [64].

This collective effective dose is defined as the sum of all the exposures from a given source to a defined group of people and has units of person-Sv. The methodology for assessing collective dose has been developed within the RIA Topic Report [16] and is summarised in this sub-chapter. Future revisions of the RIA will include an assessment of the collective doses to the general population.

3.8.2.2 Methodology

Individual and collective doses will be assessed using the methods presented in HPA-RPD-058 [64] and will be calculated using the PC-CREAM 08 software. Stage 3 individual and collective dose assessments are identified as items of Future Evidence to be provided beyond the GDA Step 2 timescale, for more detail see RIA_04 and RIA_05 respectively in Table 28. The collective dose assessment is based on population and food production grids for the atmospheric assessment and seafood catch data from local and regional compartments for the marine assessment.

Functions and capabilities of PC-CREAM 08 models and the module for assessing doses ASSESSOR have been summarised in sub-chapter 3.8.2.3. A full list of parameters required to conduct assessments using PC-CREAM 08 (for individual and collective dose assessment) is provided in the RIA Topic Report [16].

Collective doses will be calculated for UK, European[14], and World populations, truncated at 500 years, as specified in the GDA requirements listed in Table 3. Collective dose

[13] The activity concentration of I-129 in effluents from the generic SMR-300 would be well below the limit of detection and can therefore be ignored for the assessment of collective dose.

[14] Within PC-CREAM 08 there are several options for assessing exposures to European populations: EU-12, EU-25, and EU-27. All European population groups are those valid at or before the publication

assessments from routine discharges are site-specific. In the absence of a specific site during design development, the collective dose assessment can be carried out for a generic SMR-300 located at the generic coastal site described in the GSD [28]; however, it is necessary to define a local marine compartment for the effluents to be discharged to. This will be defined at a later stage when potential siting locations have been shortlisted.

PC-CREAM 08 incorporates several models:

- PLUME: An atmospheric dispersion model (Gaussian plume model), which calculates radionuclide activity concentrations in air, deposition rates and external gamma dose rates from radionuclides in the cloud (cloud gamma) at set distances from the release point.
- RESUS: A resuspension model, it estimates activity concentrations in air due to resuspension of previously deposited radionuclides.
- GRANIS: An external gamma model which models the transfer of radionuclides through soil and estimates doses one metre above the soil surface from external exposure to gamma radiation.
- FARMLAND: A terrestrial food model, which estimates the uptake of radionuclides into terrestrial foods following deposition on the ground. It calculates activity concentrations in food by category.
- DORIS: A marine dispersion model which estimates radionuclide activity concentrations in sea water, sediments and marine biota.

The outputs of the above models (activity concentrations estimated by PLUME, FARMLAND and DORIS, and effective doses estimated by GRANIS) are input into the ASSESSOR module, which scales them by the real deposition / discharge rates at various receptor locations and combines them with habit data to estimate effective doses to humans and non-human species from external radiation, ingestion and inhalation of radionuclides from various exposure pathways. Exposure pathways are specific to every model and some pathways are subject to user selection (can be enabled or disabled as required, to enable modelling flexibility) prior to the model run.

The ASSESSOR module consists of several models which can estimate individual and collective doses from atmospheric and marine discharges:

- Atmospheric collective dose (inputs are PLUME, FARMLAND, GRANIS, RESUS).
- Atmospheric individual dose (inputs are PLUME, FARMLAND, GRANIS, RESUS).
- Marine collective dose (input is DORIS).
- Marine individual dose (input is DORIS).
- Biota dose model (inputs may include PLUME, GRANIS, RIVER and DORIS).

For the purpose of Stage 3 individual and collective dose assessment, a custom site will be created within PC-CREAM 08 and site-specific meteorological and marine data etc. will be applied. Occupancy, inhalation rates and other habit data, together with site characteristics used as inputs will be those determined by the site characterisation studies and investigations.

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of PC-CREAM 08 in 2009, therefore, UK is included in each European population. EU-27 was selected for assessment as this is the most comprehensive European grouping available. The countries included in each of the European Union (EU) groupings are provided in EU Glossary: EU enlargements [111].

3.8.2.3 Input Parameters

All the parameters necessary to conduct modelling and dose assessments are listed in the RIA Topic Report [16].

When defining the candidate representative persons for the site within a Stage 3 assessment, assumptions around the individual habits are more realistic, and therefore less conservative than those assumed at Stages 1 and 2. It is necessary to define habits, including consumption rates, local vs regional or imported foodstuffs, and occupancy at various locations. As the prospective dose assessment must consider impacts on individuals across the lifetime of the reactor facility changes in habits over time must also be considered. There are several methods for estimating consumption habits considering local habit surveys (i.e. as is CEFAS Habits Surveys [89]) or Generalised Habit Data [67]. The most common method is the 'Top-Two' method, where the two foodstuffs which give rise to the highest dose when consumed at bounding rates are assumed to be consumed at bounding rates, and all other foods at average rates.[15] The options that can then be considered are:

- Actual individual ingestion rates based on local habit survey data [89].
- The 97.5th percentile and mean ingestion rates based on all consumption data in the local habit survey [89] using the 'Top Two' method.
- High-rate and mean ingestion rates based on habit survey data [89] using the 'Top Two' method.
- Generalised Habit Data [67] using the 'Top Two' method.

Similarly, for selecting occupancy data, generalised and local (individual and aggregated) habit data should be considered to identify candidate representative persons.

3.8.2.4 Assessment Results

The doses to UK, EU27 and world populations will be estimated, truncated at 500 years. The doses will be broken down by radionuclide and by exposure pathway. The outputs from the ASSESSOR atmospheric and marine collective dose models are effective doses (in person-Sv) for integration times set by the user for world, European Union (EU) and individual country (only for EU27 countries, and the UK) populations. Assessment results for individual dose will be presented in a similar manner to those presented in sub-chapters 3.5, 3.6 and 3.7.

To obtain total collective doses to world, European and UK populations, the first-pass dose component will be appropriately summed with the global circulation dose component. Examples of how these results will be presented in future assessments are provided in Table 23 and Table 24 below, for gaseous and aqueous-marine discharges respectively.

[15] Generally, as root vegetables and cow milk are the two foodstuffs with the highest consumption rates in Generalised Habit Data [67], these two foodstuffs become the two most important foods for adults and children. Consumption of fruit in infants, combined with the higher activity concentrations in fruits compared to root vegetables means that fruit may be one of the top two foods for infants.

Table 23: Atmospheric Collective Doses Truncated at 500 Years – Example Presentation

Radionuclide	Collective doses (person-Sv)		
	UK	Europe (EU27)	World
H-3			
C-14			
Kr-85 (noble-gases)			
…			
Total			

Table 24: Marine Collective Doses Truncated at 500 Years – Example Presentation

Radionuclide	Collective doses (person-Sv)		
	UK	Europe (EU27)	World
H-3			
C-14			
…			
Total			

3.8.3 Wildlife Dose Assessment

Stage 1 and 2 assessments of impacts on the ERICA reference organisms demonstrated that the impact of the SMR-300 reactor design on the environment was far below the EA screening value of 1 µGy h^{-1}. A Stage 3 assessments will be carried out as part of the permitting process for a NPP. Stage 3 wildlife dose assessments are identified as items of Future Evidence to be provided beyond the GDA Step 2 timescale, for more detail see RIA_06 in Table 28. The assessment of the impact of radioactive discharges on the environment will be completed for each site selected for the installation of a SMR-300 reactor unit. The assessment will commence with the completion of environmental surveys, which will identify any habitats and individual biota which may not be sufficiently covered by the ERICA reference organisms. Any new organisms will be modelled in ERICA and added to the ERICA database for assessment.

The Wildlife assessment, to be carried out in ERICA will utilise media activity concentration data calculated utilising the PC-CREAM 08 models described in sub-chapter 3.8.2.2 to provide the activity concentrations in air, soil, water and sediment. Alternatively, the ASSESSOR Biota model may be used to assess the impact on a smaller collection of biota, however the modelling of activity concentration over the habitat region may be better defined as ASSESSOR Biota allows for the region or regions where the representative animals and plants are located in the terrestrial environment to be specified. The results of the assessment of dose to terrestrial and marine wildlife will be presented in a similar manner to those presented in sub-chapters 3.5.3.4 and 3.5.3.5. As individual habitats will be assessed, it is possible that some species may be impacted by both gaseous and aqueous discharges, these impacts will be summed. The impacts on individual species will then be compared against the EA and ERICA screening values of 1 and 10 µGy h^{-1} respectively and the EA guideline of 40 µGy h^{-1}. The combined dose rate to habitats will be determined.

3.8.4 Potential Short-Term Doses

3.8.4.1 Introduction

In some circumstances, discharges of a significant proportion of a 12-month discharge limit may occur over a short time period as a result of certain operational practices or expected events. Expected events are defined in PER Chapter 2 as “Foreseeable deviations from planned operation (based on a fault analysis) consistent with the use of BAT, for example, occasional fuel pin failures in a reactor” [19]. It is possible that such short-term discharges may lead to doses that are higher (or lower) than would be expected if it were assumed that the discharges are continuous over a year. The RIA will include estimated doses to the public as a result of short-term releases.

A GDA Commitment to quantify transient source terms and expected events has been made in PER Chapter 2 (**C_QEDL_100**) [19]. Once transient source terms are quantified, short-term discharges will be calculated, which will enable the short-term release impact assessment to be conducted. Completion of a short-term release impact assessment has been identified as an item of Future Evidence to be provided beyond GDA (see RIA_07 and RIA_08 in Table 28).

The IRAT2 methodology, based on DPUR values, and the PC-CREAM 08 method are not appropriate for short-term elevated discharges because these methods are simplified as appropriate for continuous releases. NDAWG Guidance Note 6B [58] provides guidance for assessing doses from planned short-term releases to inform the process of proposing or setting short-term limits or notification levels.

An operational short-term release is defined in NDAWG Guidance Note 6B [58] as a release which is larger than a normal release (≥2% of 12-monthly actual or expected discharges) and occurs over a relatively short period of time (≤1 day). For a normally uniform discharge profile, this equates to about 1 week’s discharge being released in 1 day or less. Releases that occur over longer periods of time (e.g. 5 days) may be considered as a continuous release, so long as the daily release during that period does not exceed 2% of the 12-month actual or expected discharges.

Short-term doses are considered only for gaseous discharges and not for aqueous discharges into a marine environment because there is little variability in dispersion in the marine compartment and little seasonality in habits of exposed persons (i.e. fish consumption and occupancy on sediment for sea-fishers). The total dose assessed for the 12-monthly limits released in short releases will not differ significantly from the dose assessed assuming a continuous release. Hence, NDAWG recommend that there is unlikely to be a need for a short-term release assessment for discharges of radioactive substances to estuaries or coastal environments.

General guidance for assessing prospective doses from short-term releases is given in NDAWG Guidance Note 6B [58]. It states that the short-term release assessment provides an analysis of the uncertainty and variability in the continuous release assessment. When completing a short-term release assessment assumption regarding the representative person should be reasonably realistic, considering the first year following the short-term release. The doses should be compared with the SMR-300 public dose constraint (20 μSv y^{-1}) [12], source constraint (maximum of 300 μSv y^{-1}) and the dose limit (1000 μSv y^{-1}), taking into account the dose from any continuous releases for the remainder of the 12-month period. Comparison of Stage 3 short-term release impact assessment results against legal limits, dose constraints and the threshold for optimisation is identified as an item of Future Evidence to be provided beyond GDA Step 2, for more detail see RIA_09 in Table 28. The result of this dose assessment may lead to new short-term limits or levels being proposed.

3.8.4.2 Short-term Releases to Air

Short-term releases could happen as a result of an expected event, or a routine process which results in a spike in discharges of one or more radionuclides. At this current design stage, there is insufficient information to enable such analysis to be completed. Therefore, the radiological impact on members of the public from planned or expected discharges cannot accurately be assessed at this stage. The assessment method outlined in this sub-chapter will be used at a later stage once expected events such as transients and other short-term discharges are understood. A GDA Commitment to quantify transient source terms and expected events has been made in PER Chapter 2 (**C_QEDL_100**) [19]. Therefore, the assumptions and input parameter values are subject to change as the Holtec generic SMR-300 design develops and more information is known about the site and discharge patterns.

3.8.4.2.1 Assessment Methodology

Potential short-term doses, including via the food chain will be calculated for one or more local representative groups based on the methods described in NDAWG/1/2020 [58]. The pathways of exposure considered in the assessment of short-term impact include:

- Internal radiation from the inhalation of radionuclides in the effluent plume.
- External radiation from radionuclides in the effluent plume.
- External radiation from radionuclides deposited to the ground.
- Internal radiation from consumption of terrestrial food containing radionuclides deposited to the ground (not considered for radionuclides with half-lives of less than 3 hours).

3.8.4.2.2 Short-term Release Considered

The Stage 3 RIA will include a list of the expected radionuclides released during a short-term gaseous discharge and their respective activities.

To determine whether the impact of short-term discharges could be significant, it is necessary to consider a range of release durations in order to identify the bounding release, typically release durations considered range from 30 minutes to 24 hours, for a discharge rate between the monthly limit and 12-month limit (until the point in which scenario specific data is available). The maximal annual discharge values are provided in PER Chapter 2 [19], and monthly limits are currently assumed to be one twelfth of the annual limit.

Where a short-term release below the annual discharge limit is assumed, then a continuous release assessment for the remaining discharge must also be included in the assessment.

3.8.4.2.3 Site and Representative Group Parameters

The short-term dose assessment will include detailed site and representative group parameters as evidence.

The site and representative group parameters used for the dose assessments for continuous discharges are likely to be appropriate for the short-term discharges assessment, subject to any specific habits identified for short-term discharges at the specific site. In lieu of site-specific information, a release is assumed to occur on 1st July as the variation in agricultural practices and food availability throughout the year means that a summer release will be the most conservative for all foodstuffs.

3.8.4.2.4 Atmospheric Dispersion Modelling

The atmospheric dispersion model will be based on the realistic assumptions for assessing short-term atmospheric releases given in NDAWG GN 6B [58]. The atmospheric dispersion modelling code, Atmospheric Dispersion Modelling System (ADMS), is used to model the dispersion of this short-term release in the local environment to determine activity in air and deposited radionuclide concentrations [103]. The current version of the software is ADMS 6.

The duration of the short-term release will be determined at the site-specific stage. The effective release height will be determined from the height of the stack from which gaseous effluents are discharged taking into consideration other local parameters such as the release temperature, discharge velocity, and local topography, including other buildings in the vicinity of the stack. This height will therefore be determined at the site-specific stage. Meteorological conditions at the site, for the site-specific stage may take into consideration typical weather patterns at that location, especially if the geography of the site results in atypical weather patterns.

The locations of the representative person habitation and food production will be assumed to be on the centreline of the discharge plume at distances from the release point that will be determined at the site-specific stage.

3.8.4.2.5 Ingestion Dose Modelling

Dose to the critical group from ingestion of contaminated foodstuffs is considered from 1st July – 30th June following a release on 1st July. The foodstuffs considered are green vegetables, root vegetables, fruit, cow meat, cow liver, cow milk, sheep meat and sheep liver.

Ingestion models are based on the assumptions for assessing short-term atmospheric releases given in NDAWG/1/2020 [104]. The activity concentration in foodstuffs shall be taken from the FARMLAND dynamic food chain models for all radionuclides except for C-14 which uses data taken from the Food Standards Agency Product Safety Risk Assessment Methodology (PRISM) model [105], and H-3 which is taken from the PHE model Tritium Transfer Into Food (TRIF) [106]. Consumption rates for the two foods that result in the highest dose when consumed at critical rates will be assumed to be at the 95th percentile ingestion rates and the remainder at average rates. These values are presented in the RIA Topic Report [16] and are taken from Generalised Habit Data [67] which is replicated in Table A6 of NDAWG/1/2020 [104]. Grain is not included in the assessment as this foodstuff is generally consumed from regional or national supplies rather than produced and consumed locally. Foodstuffs derived from chickens and pigs are also not considered as it is assumed that they are predominantly fed on grain. Site-specific data will be used to determine the fraction of consumed food that is derived locally. Where site-specific data is not available, all food will be assumed to be derived locally.

3.8.4.2.6 Dose Calculations

Equations used for a short-term release to air dose assessment are presented in the RIA Topic Report [16].

3.8.5 Doses from Potential Build-up of Radionuclides

It is important to understand the migration and build-up of radionuclides within the environment over time. This is especially important close to the site where the highest concentrations of radioactivity will occur. Elevated levels of radioactivity in the environment could result in exposures members of the public carrying out activities on the land or local coast. It is therefore necessary to assess the impact of the build-up of radioactivity in the environment as part of a holistic RIA.

3.8.5.1 Calculation of Activity Concentration in Environmental Media

3.8.5.1.1 Method and Assumptions

The methodology for the assessment of concentrations of radionuclides in soil, seawater and sediments resulting from build-up of radionuclides in the environment is presented here. Estimation of post-closure radionuclide activity concentrations in the environment, within and adjacent to the site boundary, as a result of build-up from site discharges during operation, is identified as an item of Future Evidence to be provided beyond the GDA Step 2 timescale, for more detail see RIA_10 in Table 28. This methodology will be utilised in future design stages to support the assessment of the radiological impact on future uses of the land adjacent to the site post reactor operations. This assessment does not consider the build-up of radioactivity as a result of spills or discharges beyond routine continuous discharges. The methodology for determining activity concentrations in a range of environmental media is provided in the RIA Topic Report [16].

The long-term dispersion and accumulation of radionuclides in the environment due to continuous aqueous and gaseous radioactive waste discharges from the generic SMR-300 will be modelled using PC-CREAM 08 software, as discussed in sub-chapter 3.8.2, for assessing the dispersion and accumulation of radionuclides.

To calculate activity concentrations in soil, activity concentrations in air must be calculated. The location of highest concentration outside the site boundary will be determined at the site-specific stage, utilising data on location and relative positions of stacks together with site-specific meteorological data. This will be deemed to be the receptor point for atmospheric discharges – for both routine dose assessments and assessment of build-up of radionuclides.

All the parameters necessary for model application is provided in the RIA Topic Report [16].

3.8.5.1.2 Assessment Results

Table 25 below presents the future results format for the atmospheric, soil, seawater and sediments concentrations at the off-site location with the highest concentration following 80 years of discharges from the generic SMR-300.

Table 25: Results Format for the Atmospheric, Soil, Seawater and Seabed Sediments Activity Concentrations

Radionuclide	Activity Concentration			
	Soil (Bq/kg)	Air (Bq/m3)	Seawater - unfiltered (Bq/l)	Seabed Sediment (Bq/kg)
C-14				
Cs-137				
…				
Total				

3.8.5.1.3 Discussion

Concentrations in environmental samples taken near existing nuclear sites are presented in the annual RIFE reports (see sub-chapter 3.6.1.1). The reports include data from sites with marine discharges, including sites on which the GSD is based on, as listed in sub-chapter 3.4.3. The data can be used in support of developing the dose baseline for a potential site and can support cumulative impact assessments if necessary. RIFE reports provide a breakdown of annual doses to the public at nuclear sites by each radiation exposure pathway.

3.8.5.2 Dose Assessment for Future Land and Sea Uses

The methodology for the assessment of dose to future users of land from build-up of radionuclides in the environment is presented in this sub-chapter. This methodology will be utilised in future design stages to support the assessment of the radiological impact on future uses of the land post reactor operations.

3.8.5.2.1 Future Land Use Assessment

Assessment of the impacts of the use of radioactively contaminated land is carried out for exposure scenarios where individuals could become exposed to radioactive material. Two approaches for assessing the impact of radiologically contaminated land in the UK are explored and examined within the RIA Topic Report [16]; these are the NRPB (now UKHSA) Methodology for Estimating the Doses to Members of the Public from the Future Use of Land Previously Contaminated with Radioactivity [68] and Department of Environment Food and Rural Affairs (DEFRA)/ EA tool The Radioactively Contaminated Land Exposure Assessment methodology (RCLEA) [107]. The RIA Topic Report [16] determined the scope of future land use scenarios considered in RCLEA is narrow compared to the NRPB Contaminated Land Methodology. Furthermore, the three RCLEA future land use scenarios, residential, allotment and commercial / industrial, are sufficiently encompassed by the scenarios provided in the NRPB Contaminated Land Methodology, therefore, the RCLEA method is not considered further. An impact assessment of radionuclide build-up on future site users is identified as an item of Future Evidence to be provided beyond the GDA Step 2 timescale, for more detail see RIA_10 in Table 28.

3.8.5.2.1.1 Method and Assumptions – Future Land Use

The NRPB Contaminated Land Methodology [68] provides a methodology for estimating doses to members of the public from future use of land previously contaminated with radioactivity. The doses can be assessed using this methodology together with the activity concentrations discussed in sub-chapter 3.8.5.1. The radionuclides of interest for this assessment are those which are likely to be discharged by a PWR in significant quantities and deposited on soil, these are Co-58, Co-60, Cs-134, Cs-137, I-131 and I-133.

The methodology considers a total of seven future land use scenarios based on previously conducted assessments. Table 26 below provides scenario descriptions and a list of potentially exposed persons in each scenario.

Table 26: NRPB-W36 Future Land Use Scenarios and Exposed Persons [68]

Scenario	General Description	Exposed Person
Agriculture	Farm where contamination is assumed to be restricted to one field. Farmer spends time on the field, including manually working and ploughing the ground. Farmer and family eat produce from the farm.	Farmer (adult) Farmer's family (adult, 10yo child, infant)
Recreational area	Family members use a grassed area for recreation, e.g. dog walking or playing. Angler fishing from bank of river or lake in park. Angler and family eat catch. Swimming in the lake by all family members. A park worker spends entire working year within the recreational area and performs minor maintenance tasks.	General user (adult, 10yo child, infant) Angler (adult) Angler's family (adult, 10yo child, infant) Swimmers (adult, 10yo child, infant) Park worker (adult)
Construction	Site being developed over the course of a year for future industrial use or housing. Mechanical disturbance of soil.	Construction worker (adult)
School	School building and school playing field built on contaminated land used by adult staff and children.	School child (10y) Teacher (adult) Caretaker (adult)
Industrial	Administrative or light-manufacturing offices with small outdoor garden area.	Office worker (adult)
Housing	Housing estate consisting of a house and garden area, garden assumed partly grassed and partly used to grow foodstuffs.	Resident (adult, 10yo child, infant)
Covered area	Car park used regularly each weekday by adult. Playground used by children.	Car driver (adult) Children (10yo child, infant)

In addition to the NRPB Contaminated Land Methodology, the assessment of dose to representative groups from continuous discharges discussed in sub-chapter 3.8.2 can be used as the basis for an assessment of dose to future local users soon after operations cease.

3.8.5.2.1.2 Exposure Pathways and Spatial Distribution

Annual effective doses to members of the public are calculated considering exposure to radioactively contaminated land via eight exposure pathways in the NRPB Contaminated Land Methodology [68]:

- External exposure from contaminated ground.
- External exposure from contaminated soil on the skin.
- Inhalation of suspended contaminated material.
- Ingestion of foodstuffs grown on contaminated land.
- Inadvertent ingestion of contaminated material.
- Ingestion of drinking water from an aquifer under the contaminated land.

- Ingestion of freshwater fish caught in lake or river on contaminated land.
- Inadvertent ingestion of lake or river water on contaminated land.

Externally, the dose rates from radionuclides in contaminated soil are dependent on their spatial distribution[16] in the soil both across and under the soil. The depth profile considered in an assessment will depend on the future uses. One metre represents the maximum depth at which gamma radiation from penetrating gamma emitting radionuclides will emanate from the ground surface. Uniform exposed spatial distribution is likely to be most appropriate for land contaminated following deposition from 80 years of routine releases. Site characterisation at the site-specific stage may however reveal that local geography, topography and meteorological data has affected the deposition of activity such that there are areas with higher and lower activity concentrations, leading to a different spatial distribution. Therefore, the spatial distribution selected for the assessment will be reviewed post detailed site characterisation to ensure assessment validity.

A provisional list of parameters required to conduct a dose assessment for each land use scenario and exposure pathway is presented in the RIA Topic Report [16].

3.8.5.2.1.3 Bounding Future Land Use Scenario

To determine the future bounding land use scenario, DPUC for each land use scenario were evaluated for several key radionuclides which accumulate in soil along with typical dust loadings. The RIA Topic Report [16] found that, considering the two most significant exposure pathways (external exposure and inadvertent inhalation of contaminated material (soil / dust)), the construction scenario is bounding and the representative person is therefore the construction worker. This exercise will need to be reviewed at site-specific stage if there are any changes to the source term or other assumptions.

Assumptions, equations, parameters and DPUC for calculations of doses for the construction scenario are provided in the RIA Topic Report [16].

3.8.5.2.2 Future Sea Use Assessment

A review of potential uses of the sea has been carried out based on uses discussed in CEFAS Habits Surveys around existing nuclear licensed sites [89]. Scenarios where occupancies are high and / or intakes of radionuclides occur will result in the highest exposures.

Potential uses identified through the review of habits in CEFAS Habits Surveys [89] include: water sports; beach combing / walking; hobby fishing (including consumption of catches); commercial fishing; and, houseboat dwelling. Further marine based activities are listed in CEFAS [89] and RIFE reports [92] [93] [94] [95] [96]. The RIA Topic Report [16] determined that the bounding future sea use scenario is likely to be commercial fishing – akin to the fishing family candidate representative persons.

3.8.5.2.3 Method and Assumptions – Future Sea Use

The dose to members of the public from future use of the sea will be calculated using the methods described in sub-chapter 3.8.2. It is possible that an alternative bounding sea use

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[16] Spatial distribution considers whether the contamination is exposed, buried or disturbed and patchy or uniform distribution.

may be identified at the site-specific stage. This will be assessed at that time using appropriate methodologies, likely to be based around DORIS and ASSESSOR Marine.

3.8.5.3 Discussion of Doses from Build-up

In summary, the predicted annual dose resulting from future site use can be assessed by estimating the radiation exposure to an individual or group of individuals undertaking an activity or a series of activities. The exposed person may be exposed through a number of diverse exposure pathways so as to be considered representative of an individual who is most at risk from the build-up of radioactivity.

Predicted annual doses may be compared with the typical measured terrestrial dose rate around existing nuclear licensed sites as presented in the annual RIFE reports [92] [93] [94] [95] [96] and periodic CEFAS Habits Survey Reports [89]. They may also be compared to the annual dose calculated to the representative persons as these are calculated taking into consideration the build-up of radioactive materials in the environment following continuous discharges. In the site-specific assessment a discharge period of 80 years will be assessed.

It should be noted that the predicted annual exposure is based on the build-up of activity at the location of maximum predicted concentration outside the site boundary. The extent of this area of maximum concentration is relatively small and will reduce with distance from the site.

If the future SMR-300 site is situated in close proximity to other operating or shutdown facilities which discharge radioactive effluents or have done so historically, it will be necessary to consider the cumulative build-up and dose impacts. Site characterisation studies and surveys will determine the radiological baseline for the site, this data along with discharge information from actively discharging facilities will be used to assess cumulative impacts. In the case of actively discharging facilities, both recent discharges and build-up of radionuclides as a consequence of historical discharges will be considered in the cumulative impact assessments.

3.9 SENSITIVITY ANALYSIS

3.9.1 Introduction

Sensitivity analysis is a technique used to determine how changes to an input variable can affect the outcome of a model. It helps to identify which variables have the most significant impact on the results, thereby showing how sensitive the results are to change in input assumptions, helping to assess uncertainty and predict potential variations in results.

All parameter values derived for annual dose assessments are chosen to be realistically conservative for a UK site. There will be uncertainties in these parameter values as a result of, for example, changes and differences in individual habits and farming practices, including as a result of climate change over the planned 80-year operating lifetime of the SMR-300.

At this scoping stage, it is important to ensure that the input parameters utilised are reasonably conservative, but also that the impact of conservatism loaded upon multiple parameters does not overly skew the results.

For the RIA of the generic SMR-300, the areas considered for sensitivity analysis are the assumptions around the definition of the generic site and the habits of representative groups. The parameters considered for sensitivity analysis in this chapter are:

- Volumetric Exchange Rate.
- Reactor Lifetime.
- Stack Release Height.
- Representative Group habit data – food consumption rates and occupancies.

Once detailed site characterisation is completed at the site-specific stage, sensitivity analysis of parameters for the Stage 3 assessments will be completed to identify which variables have the most significant impact on the results, thereby showing how sensitive the results are to change in input parameters. This will help assess the uncertainty of results and predict potential variations in doses as a result of changes in the environment and local resident habits over the 80-year operational lifetime of the SMR-300. Sensitivity analysis for Stage 3 assessment parameters has been identified as an item of Future Evidence to be provided beyond the GDA Step 2 timescale, for more detail see RIA_11 in Table 28.

3.9.2 Preliminary Sensitivity Analysis of the Generic Site Description

A detailed sensitivity analysis of the site parameters defined in the GSD was carried out as part of the derivation of the GSD, as presented in the GSE Report [28]. The purpose of that sensitivity analysis was to ensure that the parameters selected were bounding of any potential future UK site. These parameters define the values used to determine activity concentrations in all media which result in a dose to members of the public and wildlife. This preliminary analysis was completed based on a range of radionuclides typically discharged from PWRs.

3.9.2.1 Impact of Site Parameters

A comparison between volumetric exchange rates of 30, 100, 231 and 3170 m^3 s^{-1} was carried out in the GSER [28] for marine discharges to ensure that the assessment of marine discharges is suitably conservative. These rates were selected as they represent:

- The IRAT2 default value.
- The assumed bounding GSD value.

- The lowest and highest exchange rates of the EN-6 reactor sites [83].

For gaseous discharges, assessments were carried out considering assumptions around stack height, receptor distance and meteorological conditions. A review of the impact of stack height on activity concentration in air at a range of receptor distances was carried out. Additionally, a review of weather conditions around UK coastal and inland sites was carried out to assess whether the 50% Pasquill Stability Category D assumption is sufficiently bounding for all potential sites as an annual average. This considered impact of stability category on activity concentrations as well as prevalence of stability categories at different UK locations. Changes in stack height or weather category could result in changes to peak air concentrations and deposition at different distances to those assumed in the GSD for the public and non-human receptors and food production[17]. As the stacks are yet to be defined for the generic SMR-300, this sensitivity analysis was important to identify the level of conservatism in the assumption of a ground level release.

3.9.2.2 Impact of Reactor Lifetime on Dose Assessment

The IRAT2 spreadsheets are limited by the integration time for assessment of individual dose. Doses are assessed at year 50. The expected operating lifetime of the generic SMR-300 is 80 years; therefore, the build-up of radioactivity in the environment and thus the dose assessment may be underestimated. The UK European Pressurised Reactor (EPR) GDA study [108] assessed the impact of reactor lifetime on the modelling results, for the radionuclides of interest to the UK EPR gaseous and aqueous marine discharges. These studies concluded that for the majority of radionuclides, activity concentrations in air, soil, water, and sediment reached equilibrium long before year 50, therefore, for those radionuclides an increased operating time would not result in an increased dose. Similar studies for the SMR-300 source term have been completed, these show that the increase in activity concentration between year 50 and the peak was not substantial for the few long-lived radionuclides that do not achieve equilibrium by year 50. Therefore, with other conservatisms built into the model it can be concluded that the results of the assessments in this report will still bound any real impacts from the operation of twin reactor units in the generic SMR-300.

3.9.3 Sensitivity Analysis of the Site Parameters

Further sensitivity analysis has been conducted, to include the final list of radionuclides and any changes made to assumptions since the initial analysis.

3.9.3.1 Marine Parameters

IRAT2 assumes that there is a linear relationship between volumetric exchange rate with the neighbouring regional compartment and activity concentrations in water and sediments. This relationship is valid down to an exchange rate of 100 $m^3 s^{-1}$, at lower exchange rates, to about 30 $m^3 s^{-1}$, the dose is cautious by approximately a factor of two. Therefore, for the Stage 1 and 2 assessments completed in this report no further sensitivity analysis is required.

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[17] As the design develops over post-GDA timescales, further sensitivity analysis of the site parameters will be need to be taken into consideration, factors such as stack height, local meteorological conditions, entrainment and building wake, exhaust velocity and temperature.

3.9.3.2 Atmospheric Parameters

Initial assessment of atmospheric discharges did not consider isotopes of krypton nor all of the iodine isotopes. Further analysis of the impact of stack height, including these isotopes has been carried out, utilising the discharge limits. The analysis shows that increased stack height results in a reduction in dose. This analysis is simplistic, as IRAT2 does not take into consideration the peak activity concentration at each stack height which would no longer be at 100 m from the stack (as discussed in the GSE Report [28]). Maintaining a source to receptor distance of 100 m, the dose to the local resident for a 10 m effective stack height is approximately 30% that of a ground level release, and an 80 m effective stack height would result in a dose that's just 2% of that of a ground level release, as shown in Figure 2. This preliminary analysis demonstrates that the greatest benefit would be achieved with an effective stack height in the region of 20 m. Therefore, it is vital that the stack height is optimised as part of a BAT study to ensure that exposures are ALARA.

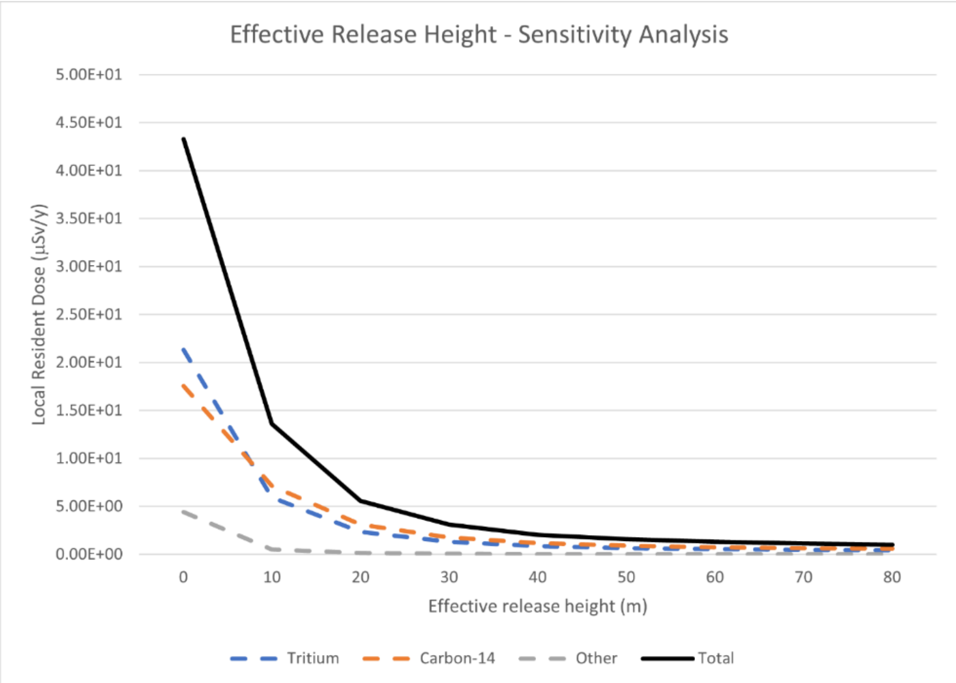

Figure 2: Sensitivity Analysis of Effective Release Height

3.9.4 Sensitivity Analysis of the Representative Group Habits

Assumptions made within IRAT2 for exposure group habits are likely to be bounding for almost all potential representative group scenarios. For example: foods are assumed to be locally sourced, and ingestion is at 97.5 percentile ingestion rates for all foodstuffs; the local resident family is assumed to have 100% occupancy at the location of peak concentration; and the fisher is assumed to fish from the beach as a full-time occupation.

The doses to more representative individuals would therefore be lower as:

- Inhalation accounts for over half of the dose to the gaseous exposure group, therefore, any change in occupancy location or time spent indoors would significantly alter the total dose[18].
- Ingestion accounts for around a third of the dose to the gaseous exposure group, by using more representative ingestion habits, or a 'top-two' approach for assessment would reduce the ingestion component of the dose.
- Ingestion of seafoods accounts for 99% of the aqueous-marine exposure group dose, therefore any change to consumption rates or source (local vs regional compartment, or purchased from further afield) of fish would have a substantial impact on the dose.

In the assessment of exposures to wildlife, IRAT2 assumes the ERICA reference organisms are present. Without any other site-specific data, this is a reasonable assumption and covers most groups of species with a generic reference organism. At a site-specific stage, it is necessary to carry out habitat surveys to identify species present at or close to site to determine whether there are other organisms that, as a result of their behaviours (e.g. foods consumed, shape and size or dwelling location) could result in doses greater than the reference organisms.

[18] This is in addition to a reduction in the activity concentration as a result of the increased stack height.

3.10 SUMMARY

This chapter provides information concerning the methodologies and approaches that have been used to perform Stage 1 and 2 assessments of the radiological impacts on members of the public and the environment from gaseous and aqueous discharges from a twin generic SMR-300 facility at a generic UK site as required by the UK regulators of RPs within the GDA process. It also presents information on the methodologies and data requirements to perform Stage 3 assessments including assessment of impacts from short-term discharges, collective dose to national and global populations and the impact of the build-up of radioactivity in the environment.

The coastal generic site has been considered in these assessments: a site located on the coast of England or Wales and adjacent to an existing nuclear site. These preliminary assessments have not taken into consideration the impact of historic or ongoing discharges from any other reactors. At this stage of design, data requirements have been identified in order to be able to conduct the initial impact assessments.

The approaches are based on the generic SMR-300 design to date, as per the current DRP [2], data determined from design specifications and operations of other PWRs, and calculated discharge data from the generic SMR-300, as well as site-specific variables as defined for the generic site. A discussion of Stage 1 and Stage 2 RIAs is included, as well as sensitivity analysis for key site and habit parameters.

This assessment demonstrates that doses from effluent discharges at a coastal site can be deemed to be ALARA and in line with EA guidance and limits once more realistic parameters are utilised. Doses to the candidate representative group at the coastal site are below the site and source constraint, [REDACTED] A 10 m effective stack height alone would result in an overall two-thirds reduction in dose resulting from atmospheric discharges. With increased stack height, ingestion becomes the principal exposure pathway, however the conservatisms in consumption rates result in far higher doses than would be exhibited utilising more realistic habits.

[REDACTED] it is necessary for a Stage 3 assessment to be completed, as indicated in Figure 1. This may be completed at a later detailed design stage when site parameters are better understood, and updated discharge source terms are available – especially those related to transient and other short-term discharges utilising an updated GSD or, completed once a site has been chosen, utilising site-specific characteristics. sub-chapter 3.8 provides information on the methods and input parameters to complete these assessments.

The generic SMR-300 design is under development, and discharge source terms are being developed as the aqueous and gaseous effluent treatment systems are designed. The underlying assumptions, parameter values, operating experience data and engineering design presented in this report are subject to change.

3.11 GDA COMMITMENTS AND FUTURE EVIDENCE

Beyond the GDA timescale, the management of the RIA of the SMR-300 will continue to develop in line with the evolving maturity of the generic SMR-300.

GDA Commitments for future stages of regulatory engagement are captured and recorded in accordance with the Commitments, Assumptions, Requirements (CAR) [109] procedure. Table 27 below presents the GDA Commitment raised in this chapter.

Table 27: GDA Commitments

Chapter Reference	Reference	Description of Commitment	Target for Resolution
3.5.3.2.2	C_RIA_126	Further information is required on the detailed design of the ventilation systems and discharge stacks of the SMR-300 to enable a Stage 2 refined assessment to be completed. A Commitment is raised to update the generic site description and complete a refined Stage 2 Radiological Impact Assessment once the height and relative position of each stack becomes available to enable more realistic dose estimates.	Issue of UK Pre-Construction SSEC

Table 28 below presents additional post-GDA work to be undertaken to produce future evidence for the SSEC.

Table 28: Future Evidence

[REDACTED]

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