Permitting new nuclear power stations

Environmental permitting of NNB Generation Company (Sizewell C) Limited

Consultation document: radioactive substances activities

July 2022

Version 1

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We can't do this alone. We work as part of the Defra group (Department for Environment, Food & Rural Affairs), with the rest of government, local councils, businesses, civil society groups and local communities to create a better place for people and wildlife.

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Horizon House, Deanery Road,
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This consultation – at a glance

Topic

This consultation is about the Environment Agency's proposed decision on the application made by NNB Generation Company (SZC) Limited for an environmental permit.

The application was made under the Environmental Permitting (England and Wales) Regulations 2016 (EPR 2016) to carry on radioactive substances activities associated with the operation of a new nuclear power station at the Sizewell C site, near Leiston, in Suffolk.

Geographical scope

England only.

Audience

This consultation is aimed at:

- members of the public
- the communities local to the site for which the permit has been applied
- statutory consultees
- academics with an interest in nuclear power, energy production or the environment
- non-governmental organisations (NGOs)

Comments from any other interested parties are also welcome.

Duration

12 weeks.

Contact details

Please complete the online response form on our consultation hub. Alternatively, you can email your response to: psc@environment-agency.gov.uk or write to us at:

Sizewell C Consultation
Environment Agency
Permit Support Centre
Quadrant 2
99 Parkway Avenue
Park way Business Park
Sheffield
S9 4WF

If you have any queries, or would like a hard copy of this document, please email us at: psc@environment-agency.gov.uk

Next steps

Our determination of NNB Generation Company (SZC) Limited's application continues and we have not yet reached any final decision. We will complete our determination, including carefully considering all relevant comments made during consultation and will produce a final decision document that:

- sets out our decision on whether or not to issue a permit to NNB Generation Company (SZC) Limited
- summarises the consultation responses and issues raised
- sets out our views on those issues

We expect to:

- publish our final decision document at the end of our determination, which we are targeting to complete in early 2023

Opportunities to have your say on other Sizewell C permits

NNB Generation Company (SZC) Limited also applied for 2 other environment permits required to operate Sizewell C. These permits are for the discharge of cooling water and trade effluent (application reference EPR/CB3997AD/A001) and the operation of the standby diesel generators (application reference EPR/MP3731AC/A001). We are currently consulting on our proposed decisions for these 2 permits. Details of these consultations can be found on our dedicated Sizewell pages and our consultation hub.

Executive summary

This document is prepared for public consultation on our proposed decision on the application NNB Generation Company (SZC) Limited made for an environmental permit. The application is made under the Environmental Permitting (England and Wales) Regulations 2016 (EPR 2016) to carry on radioactive substances activities associated with the operation of a new nuclear power station at the Sizewell C site, near Leiston, in Suffolk. These activities are the discharge and disposal of radioactive wastes from the site.

We advertised the application and consulted the public and other stakeholders on it between 6 July and 2 October 2020. We have assessed the application, considered the consultation responses we received and have made a proposed decision to grant the application subject to the conditions in the draft permit that accompanies this document. Our processes require further public consultation on our proposed decision and draft environmental permit. The purpose of this consultation is to seek your views on our proposed decision and draft permit to help us come to a final decision.

We will not make a final decision about this application until we have carefully considered the responses to this public consultation.

The proposed nuclear power station has 2 pressurised water reactors based on EDF and AREVA's UK EPR™ design (EPR™). The total expected net electrical capacity is 3,260MW.

The site-specific application NNB Generation Company (SZC) Limited made builds on information provided during the Generic Design Assessment (GDA) of the UK EPR™ reactor design. In this GDA, we assessed the acceptability for use in England and Wales of the UK EPR™ on environment protection and waste management matters. The Office for Nuclear Regulation assessed its use in the United Kingdom on safety and security issues. We issued a final Statement of Design Acceptability (SoDA) in December 2012.

In 2013, we completed an assessment of an application from NNB GenCo Ltd, now called NNB GenCo (HPC) Ltd, for radioactive substances activities at the Hinkley Point C (HPC) nuclear licensed site in Somerset which is currently under construction. NNB Generation Company (SZC) Limited is a sister company to NNB GenCo (HPC) Ltd. The nuclear power station at Hinkley Point C is of the same design, and NNB Generation Company (SZC) Limited proposes to replicate, so far as is practicable, the Hinkley Point C development at the Sizewell site.

The Sizewell site is located on the east coast of the United Kingdom, approximately 1.5km north-east of the town of Leiston in the county of Suffolk. NNB Generation Company (SZC) Limited proposes to construct a new nuclear power station at a location immediately north of the existing Sizewell A and B power stations. The proposed new power station is known as Sizewell C.

The company has applied for operational environmental permits many years ahead of planned operations beginning. It is expected that any discharges or disposals of radioactive waste would not take place from Sizewell C (SZC) before the mid-2030s. However, we consider that there are significant benefits in regulating at an early stage of site-specific design and during the development of the operator's organisational capabilities. We recognise that the detailed arrangements for operations and compliance are not yet fully developed. However, we still require suitable arrangements and resources to be in place for each phase of the project. This will help ensure that, when operations begin, the power station, its arrangements and resources are ready and suitable to maintain compliance with the requirements of our permits.

Radioactive waste would be produced by activities associated either directly or indirectly with operating and maintaining the nuclear reactors. When we permit radioactive substances activities, we require operators to minimise the activity and volume of radioactive waste produced and its impact on the environment and public through the application of best available techniques (BAT).

Operating the reactors would generate radioactivity in the water of the reactor's primary circuit and, despite the water being treated, some will subsequently become waste discharged to the environment. Radioactive wastes produced by operating the nuclear reactors would include:

- gaseous radioactive waste discharged to the environment mostly via 2 main outlet stacks, one for each reactor
- aqueous radioactive waste discharged with the cooling water into the North Sea, at a point approximately 3.4 kilometres offshore
- solid radioactive waste produced during the treatment of gaseous and liquid waste, and during the operation and maintenance of the power station. Low-level solid radioactive wastes, oils and solvents would be transferred to off-site treatment and disposal facilities, while higher activity solid waste would be stored on-site until it decays to low level waste (allowing it to be disposed of) or until suitable disposal facilities become available

Prior to public consultation on our proposed decision and draft permit, we are satisfied that the radiation dose rates to the public and wildlife associated with permitted discharges from the Sizewell C site would be well below:

- the UK's statutory radiation dose limit for members of the public of 1,000 microsieverts a year (μSv/y)
- the source (300μSv a year) and site (500μSv a year) dose constraints
- below our guideline level for non-human species of 40 micro Gray an hour (μGy/hour)

We have assessed the total dose to the representative person from discharges of radioactive waste and direct radiation from the proposed Sizewell C station as 4.7μSv a year. We have also assessed the total dose to a representative person from both past and future discharges of radioactive waste from all 3 Sizewell stations (A, B and C sites) at the permit limits as 28μSv a year.

1. About this consultation document

This is a document setting out our proposed decision and it is accompanied by a draft permit. It explains how we have considered NNB Generation Company (SZC) Limited's (afterwards referred to as NNB GenCo (SZC)) application and why we have included the specific conditions in the draft permit we are proposing to issue. It is our record of our decision-making process so far, to show how we have considered relevant matters in reaching our proposed decision.

The document sets out our proposed decision because we have yet to make a final decision. Before we make this decision, we want to explain our thinking to the public and other interested parties, to give them an opportunity to understand that thinking and, if they wish, to make comments to us. We will make our final decision only after carefully considering relevant matters raised in the responses we receive. At that time, we will make our final decisions about whether we should issue a permit for Sizewell C and, if so, the conditions that the permit should place on the operator.

Unless we receive information that leads us to alter the conditions in the draft permit, or to reject the application altogether, we will issue the permit in its current form.

This document includes:

- a description of how we process and determine applications (Chapter 2)
- a summary of the application and brief details of our consultation on the application (Chapter 3)
- a description of our assessment (Chapters 4 to 8)
- a statement of our proposed decision (Chapter 9)
- a summary of consultation responses (Appendix 1)
- a summary of how the EPR™ GDA Assessment Findings will be addressed at Sizewell C (Appendix 2)

Invitation to comment

This consultation seeks your views on our proposed decision following our detailed assessment of NNB GenCo (SZC) permit application. We will carefully consider your views in reaching our final decision on whether to issue a permit.

We want to hear from all interested parties. When responding, please state whether you are responding as an individual or representing the views of an organisation.

We will be undertaking a 12-week consultation.

How to respond

There are a number of ways you can let us know your views.

Online

Visit our website at https://consult.environment-agency.gov.uk. We have designed the online consultation to make it easy to submit responses. We would prefer you to comment online as this will help us to gather and summarise responses quickly and accurately.

By email or letter

You can also submit a response by email or letter. It would help us if you would send your comments. Send them to:

Email: psc@environment-agency.gov.uk

By post:

Sizewell C Consultation
Environment Agency
Permit Support Centre
Quadrant 2
99 Parkway Avenue
Park way Business Park
Sheffield
S9 4WF

Data protection privacy notice

How we will use your information

We will look to make all responses publicly available during and after the consultation, unless you have specifically requested that we keep your response confidential. All comments which are made publicly available will exclude email addresses and telephone numbers.

We will not publish names of individuals who respond.

In accordance with the Freedom of Information Act 2000 and the Environmental Information Regulations 2004, we may be required to publish your response to this consultation but will not include any personal information. If you have requested your response to be kept confidential, we may still be required to provide a summary of it.

For more information see our Personal Information Charter.

Keeping up to date

We would like to keep you informed about the outcomes of the consultation. If you would like to receive an email acknowledging your response, and be notified that the final decision document has been published please give us your email address.

By providing us with your email address you consent for us to email you about the consultation. We will keep your details until we have notified you of the final decision document publication.

We will not share your details with any other third party without your explicit consent unless required to by law.

You can withdraw your consent to receive these emails at any time by contacting us at: psc@environment-agency.gov.uk with the subject "CONSULTATION: Sizewell C operational permits".

The Environment Agency is the data controller for the personal data you provide. For further information on how we deal with your personal data please see our Personal Information Charter on gov.uk (https://www.gov.uk/government/organisations/environment-agency/about/personal-information-charter) or contact our Data Protection team at:

Data Protection team
Environment Agency
Horizon House
Deanery Road
Bristol
BS1 5AH

Or email: dataprotection@environment-agency.gov.uk

Consultation and engagement plan

A programme of communications and stakeholder engagement is underway and we will continue this during the consultation period.

You can read our engagement plan for Sizewell C's environmental permits at https://www.gov.uk/government/publications/sizewell-c-engagement-plan/environment-agencys-engagement-plan-for-sizewell-cs-environmental-permits

You can read further information on our work at Sizewell at https://www.gov.uk/guidance/sizewell-nuclear-regulation

Our plan includes events with stakeholders. These will be held online, by telephone or in person, unless Environment Agency guidance prevents this. They will be advertised to stakeholders at the start of the consultation.

What happens next?

We will acknowledge receipt of your response. We will consider carefully all the responses we get. If issues arise that fall outside our responsibilities, we will pass them to the appropriate government department or public body.

Your comments, where relevant to the scope of our assessment, will help us decide whether or not to issue a permit to NNB GenCo (SZC) at Sizewell C.

We will publish a final decision document that:

- sets out our decision
- summarises the consultation responses and issues raised
- sets out our views on those issues

We expect to do this early in 2023.

Consultation principles

This consultation is being conducted in line with the Cabinet Office's "Consultation Principles" which can be found at:
https://www.gov.uk/government/publications/consultation-principles-guidance

If you have any questions or complaints about the consultation process, please address them to our Consultation Coordinator at:

Consultation Coordinator
Environment Agency
Horizon House
Deanery Road
Bristol
BS1 5AH

Or email: consultation.enquiries@environment-agency.gov.uk

Consultation questions

Below is a list of the questions that we are asking for responses to, as part of this consultation on our proposed decision.

Do you have any views or comments on our conclusions on:

1. General considerations and Operator competence (Chapter 4)?
2. The use of the best available techniques for the management and disposal of radioactive waste (Chapter 5)?
3. Limits and notification levels (Chapter 6)?
4. Assessment of radiation doses to people and dose rates in the environment (Chapter 7)?
5. Other environmental considerations (Chapter 8)?

Additionally:

Do you have any overall views or comments to make on our assessment, not covered by the previous questions?

2. How we process and determine applications

The Environment Agency is responsible, under the Environmental Permitting (England and Wales) Regulations 2016 (EPR 2016) (UK Parliament, 2016a), for regulating certain radioactive substances activities in England, namely:

- where the operator is not a nuclear site licensee, the keeping or use of radioactive material or the accumulation of radioactive waste
- the keeping or use of mobile radioactive apparatus
- the receipt of radioactive waste for the purposes of disposing of that waste
- the disposal of radioactive waste on or from the premises into the air, the sea, rivers, drains or groundwater; disposals to land; and by transfer to another site

A 'nuclear site' is one that holds, or on a reasonable time frame is one that is expected to hold, a nuclear site licence under the Nuclear Installations Act 1965 (NIA 65). On a nuclear licensed site, the Office for Nuclear Regulation (ONR) will regulate the keeping and use of radioactive materials.

We regulate nuclear sites with the purpose of protecting members of the public and the environment from harm by ensuring that the discharge and disposal of radioactive wastes are minimised and their impact is acceptable. We regulate within a framework of legislation, government policy, strategy and guidance on the management and disposal of radioactive waste. This framework is summarised in the government guidance on radioactive substances regulation (UK Parliament, 2011). The guidance sets out the government's position on how radioactive substances regulation (RSR) should be applied and implemented and how terms should be interpreted by both the Environment Agency and operators. This is more recently described in How we regulate radiological and civil nuclear safety in the UK (UK Parliament 2021).

In summary, we require operators to protect people and the environment by using best available techniques (BAT) to:

- minimise the generation of radioactive waste
- minimise the amount of radioactive waste that must be discharged into the environment
- discharge that waste in ways that minimise the resulting radiological impact on the public and protect the wider environment
- use the optimal route for the disposal of solid radioactive wastes

2.1. Our process

We follow a 2-stage process for assessing and permitting new nuclear power stations:

1. Requesting Parties may apply to the Department for Business, Energy and Industrial Strategy (BEIS) for ministers to request the regulators (Environment

Agency and ONR) to carry out a Generic Design Assessment (GDA) of their design. If the GDA is carried out the regulators will assess the design for its acceptability for use.

2. A prospective operator of a reactor that wishes to carry out a radioactive substances activity must apply for a site-specific permit.

Generic Design Assessment is discussed further in section 2.1.1, while the site-specific permitting is discussed in section 2.1.2.

2.1.1. Generic Design Assessment

In the first phase, Generic Design Assessment (GDA), we carry out a detailed assessment of the features of a candidate reactor design that can affect those aspects of its environmental performance that we regulate. If we are fully content with the environmental aspects of the generic design, we provide a Statement of Design Acceptability (SoDA). If we are largely content, but there are GDA Issues (that is, significant but resolvable outstanding matters), we issue an interim Statement of Design Acceptability (iSoDA). In both cases, we also identify Assessment Findings. These are matters which a future operator will need to address at the appropriate stage of a new build project, that is, during detailed design, procurement, construction, commissioning or early operation. Where we have issued an iSoDA, we expect the designer to provide further information as it implements its resolution plan. We close GDA Issues if we are satisfied that they have been resolved. Once all GDA Issues are closed, we will consider issuing a full SoDA.

We have carried out GDA of the UK EPR™ design from Electricité de France SA and AREVA NP SAS ('EDF and AREVA') and we issued a final SoDA for the UK EPR™ in December 2012. Our decision is documented in our 2011 UK EPR™ decision document (Environment Agency, 2011) and 2012 Supplement to the Decision Document (Environment Agency, 2012a). Our Assessment Findings from GDA are discussed in the relevant parts of chapters 4 to 8, and how they will be addressed at Sizewell C (SZC) is addressed in Appendix 2.

2.1.2. Site-specific permitting

In the second phase, we receive applications for environmental permits for specific sites. In determining these applications, we take full account of the work we have done during GDA so that our efforts are focused on operator and site-specific matters. This includes how the operator has addressed GDA Assessment Findings and any changes to the GDA design arising from the site-specific considerations or operator required modifications.

Operators can apply to the Environment Agency for a new permit or a variation to an existing permit at any time. We recommend that GDA is concluded prior to site-specific permit application but recognise that this may not always be the case. Where an application is based on a GDA, we require a SoDA or iSoDA to be issued prior to consulting on a proposed decision on the permit application. Where we have issued an iSoDA, we would expect the GDA Issues to be resolved before we would issue a permit.

In the case of Sizewell C, NNB GenCo (SZC) proposes to replicate the station under construction at Hinkley Point C so far as possible, subject to the site's different characteristics and other relevant matters. Our considerations will include the work we carried out in the GDA for the UK EPR™ and for the NNB GenCo (HPC) project in Somerset for which we issued permit EPR/ZP3690SY in March 2013. Although the 2 projects are being run by separate legal entities, they both have a significant shareholding by the EDF group of companies and have arrangements in place to share the design, knowledge and experience to benefit both.

2.1.3. Our permitting process

The process we follow in assessing an application is described in the government's EPR core guidance (UK Parliament, 2020) and in our Guidance on the regulation of radioactive substances activities on nuclear licensed sites (Environment Agency, 2012b).

The process for permit application for nuclear sites is outlined below.

1. Pre-application - We encourage applicants to discuss applications with us before submission.
2. Receive the application and consult on the application - The applicant makes an application, providing the information as set out in the application form and supporting guidance. We advertise and consult on all applications for new permits.
3. Assess the application and propose a decision for consultation - We carefully assess the application and any responses to our consultation. We then come to a proposed decision on whether to grant the permit and, if so, the appropriate permit conditions.
4. Consultation on proposed decision - We may choose to carry out further consultation on our proposed decision and draft permit, depending on the nature of the proposals and the likely degree of public interest. We do this using a document that explains our proposed decision and a draft permit.
5. Review, approval and issue of decision - Where we consult on our proposed decision, we carefully consider all relevant information we have received during and after consultation, together with existing information. We make a decision on whether we should issue a permit, and if so, what its conditions should be. We publish a document that explains our decision.

2.2. Legal, policy and regulatory considerations

We have come to our proposed decision taking into account all relevant legal, policy and regulatory matters. The legal requirements and government policy relating to the management of the generation and disposal of radioactive waste are set out in the Government guidance on radioactive substances regulation (UK Parliament, 2011). The government has also issued Statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment (UK Parliament, 2009). This states that we should base our decision on the principles set out in the UK Strategy for radioactive discharges (UK Parliament, 2009), namely:

- regulatory justification of practices by the government
- optimisation of protection on the basis that radiation doses and risks to workers and members of the public from a source of exposure should be kept as low as

reasonably achievable, taking social and economic factors into account (the ALARA principle) and within the relevant radiation dose constraints
- application of limits and conditions to control discharges and to ensure that any radiation exposure of the public is within the statutory dose limit of one millisievert per year
- protection of non-human species and the wider environment
- sustainable development
- the use of best available techniques (BAT)
- the precautionary principle
- the polluter pays principle
- the preferred use of 'concentrate and contain' in the management of radioactive waste over 'dilute and disperse'

Our Radioactive Substances Regulation RSR Objective and Principles (Environment Agency, 2021) and RSR generic developed principles: regulatory assessment (Environment Agency, 2021) set out a consistent and standardised framework for the technical assessments and judgements that we make when regulating radioactive substances.

Our assessment of the application is set out in chapters 4 to 8, in a structure that reflects the layout and questions in the application form. Section 2.2.2 identifies the main issues we need to consider when making decisions on the disposal of radioactive waste. It also refers to the relevant reference documents and guidance (most of these documents can be accessed from our nuclear regulation technical guidance page on GOV.UK website). In chapters 4 to 8 we explain how we have reached our proposed decision against these and any other relevant considerations.

2.2.1. Role of the Secretary of State

Although we will normally determine an application, the Secretary of State can require any application to be referred to him/her for determination (regulation 63 of EPR 2016). As noted in the EPR core guidance (UK Parliament, 2020), this would be an exceptional step and likely to be taken only if the application involves issues of more than local importance, for example, if the application:

- is of substantial regional or national significance
- is of substantial regional or national controversy
- may involve issues of national security or of foreign governments

The core guidance also says that any decision on the need for determination by the Secretary of State would be made solely on those grounds, with no consideration of the substantive merits of the application itself. The Secretary of State has not requested that this application be referred to them for determination.

In specific circumstances and within statutory timescales, appeals regarding the determination of an application must be made to the Secretary of State. They may appoint another person, generally the Planning Inspectorate (PINS) to determine an appeal on their behalf. Further details regarding appeals can be found in EPR core guidance (UK Parliament, 2020)

2.2.2. Principal considerations

The following section lists the principal considerations and associated guidance we have taken into account in coming to our draft determination.

General

- Government guidance on radioactive substances regulation (UK Parliament, 2011)
- The regulation of radioactive substances activities on nuclear licensed sites (Environment Agency, 2012b)
- Radioactive Substances Regulation RSR Objective and Principles (Environment Agency, 2021a)
- RSR generic developed principles: regulatory assessment (Environment Agency, 2021b)

Justification

- Appendix of Government policy - radioactive & nuclear substances (UK Parliament, 2015a)

EURATOM article 37

- Commission recommendation 2010/635/Euratom (EU, 2010)

Operator and operator competence

- Legal operator and competence requirements web guide (Environment Agency, 2016)
- Management arrangements at nuclear sites (Environment Agency, 2010b)

Disposal of radioactive waste

- Statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment (UK Parliament, 2009a)
- RSR: Principles of optimisation (Environment Agency, 2010c)
- UK Strategy for Radioactive Discharges 2009 (UK Parliament 2009b) and UK Strategy for Radioactive Discharges 2018 review of 2009 strategy.(UK Parliament 2018a)
- Criteria for setting limits on the discharge of radioactive waste from nuclear sites (Environment Agency, 2012c)

Radiological monitoring

- RMTGN2 - Environmental radiological monitoring (Environment Agency and others, 2010)

Radiological assessments

- Principles for the assessment of prospective public doses (Environment Agency and others, 2012)

Other statutory requirements

We also take into account other requirements, see chapter 8 for details of these.

2.3. Public and stakeholder engagement

It will always remain the regulator's responsibility to make decisions about the permits. However, we want our decisions to be better informed through good engagement. We want to be aware of and understand people's comments and views. Where relevant, we can use these to help inform our assessments of the permits.

We advertised and consulted on this application in accordance with our Public Participation Statement (Environment Agency, 2019) and the government's published consultation principles. In view of the nature of the application and the degree of public interest, we have decided to carry out further consultation on our proposed decision and draft permit.

Aarhus Convention

The UK is a signatory to the United Nations' Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, known as the Aarhus Convention. The Convention sets out an individual's rights to public participation in decision-making and the requirements on a public body to make sure that public participation in decision-making is carried out properly. The relevant requirements of the Convention are given effect by the public participation duties placed on us by the EPR 2016, including informing people about applications that we consider they are likely to be interested in or affected by, and inviting them to make representations. How we decide who to involve is described in our Public participation statement (Environment Agency, 2019), which we are required to publish by regulation 60 of the EPR 2016.

Espoo Convention

The UK is a signatory to the United Nations' Convention on Environmental Impact Assessment in a Transboundary Context, usually known as the Espoo Convention. The Convention requires the parties signed up to it at state level to:

- notify each other as early as possible of any transboundary impacts
- prevent, reduce and control the impact of any proposed measures
- allow the public, in areas likely to be affected, to participate in relevant environmental impact assessment procedures

In the UK, the Department for Business, Energy and Industrial Strategy (BEIS) is the government department responsible for making any notification, as required in the current context by the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.

3. The application and our consultation on the application

NNB Generation Company (SZC) Limited (NNB GenCo (SZC)) has applied for a permit to carry out radioactive substances activities at the Sizewell site in Suffolk. These activities are the discharge and disposal of radioactive wastes from the site.

NNB GenCo (SZC) (Company number 09284825) was incorporated in 2014. It is a wholly owned subsidiary of NNB Holding Company (SZC) Limited, which, in turn, is owned by EDF Energy Holdings Limited (80% share) and General Nuclear International Limited (20% share). The relative shareholdings and shareholders in NNB Holding Company (SZC) Limited may change during the project phases (preparations, construction, and operation). EDF Energy Holdings Limited and General Nuclear International Limited are ultimately owned by EDF SA and China General Nuclear Power Corporation (CGN) respectively. NNB GenCo (SZC) is known locally, and for some of the planning applications, as 'EDF SZC Co'.

The application consists of the relevant RSR environmental permit application forms and a submission of information to provide the required detailed technical information. NNB GenCo (SZC) provided the following documents as supporting information:

- Non-Technical Summary
- Head Document — This provides an overview of the application, including a description of the Sizewell C site and NNB GenCo (SZC)'s proposed activities
- Support Document A1 - Environment Case
- Support Document A2 - Integrated Radioactive Waste Strategy
- Support Document B - Discharge Limits for Radioactive Waste
- Support Document C1 - Plant Monitoring
- Support Document C2 - Environmental Monitoring
- Support Document D1 - Human Radiological Impact Assessment
- Support Document D2 - Non-Human Biota Radiological Impact Assessment
- Support Document E1 - Company Manual
- Support Document E2 - Management System Manual
- Support Document E3 - RSR Compliance Matrix
- Appendix F - Site Plan
- Appendix G - Glossary and Abbreviations
- Appendix H - Cross Reference to Environment Agency Guidance and GDA UK EPR™ Documentation

The further information provided during our assessment of the application (section 3.6 further information) also forms part of the application.

3.1. Site location

The proposed facility would be located on the east coast of the United Kingdom approximately 1.5km north-east of the town of Leiston in the county of Suffolk. The proposed location of the new nuclear power station is immediately north of the 2 existing Sizewell power stations.

The proposed site is situated within the Suffolk Coast and Heaths Area of Outstanding Natural Beauty (AONB) and there are a number of international and national environmentally designated sites close to it. These are:

- Sizewell Marshes Site of Special Scientific Interest (SSSI)
- Minsmere-Walberswick Heaths and Marshes SSSI, part of which is designated as a Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar site
- Leiston-Aldeburgh SSSI
- Sandlings SPA
- Outer Thames Estuary SPA

NNB GenCo (SZC) has provided a description of these sites in the Head Document and in section 2 of Support Document D2 submitted as part of its application.

3.2. Description of proposed facility

NNB GenCo (SZC) has provided a description of the proposed facility in section 2 of the Head Document submitted as part of its application.

The proposed new nuclear power station would comprise 2 UK EPR™ units. The UK EPR™ is a pressurised water reactor.

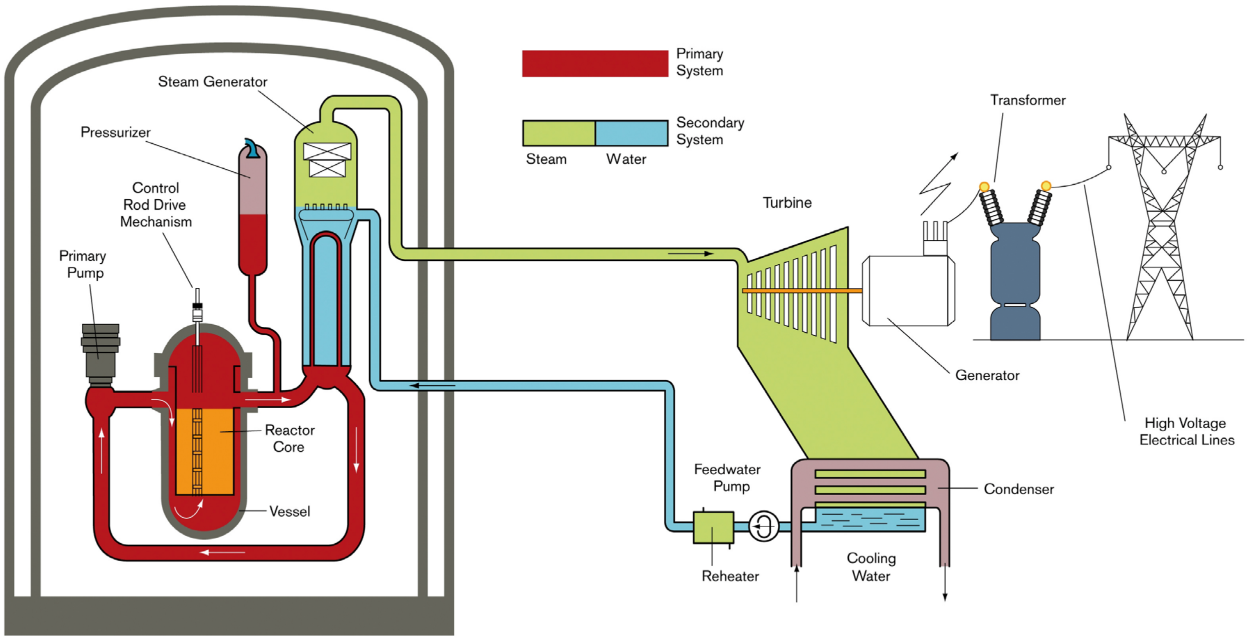
In a pressurised water reactor, uranium oxide fuel in the reactor core undergoes fission which generates heat. The reactor core is cooled by water in a pressurised circuit. Heat is transferred from the primary pressurised circuit to an isolated secondary circuit where it is used to produce steam. The steam produced is used to drive a turbine generator to produce electricity. Figure 3.1 provides a simplified schematic of the EPR™, this diagram is reproduced from the Head document in NNB GenCo (SZC)'s application.

In addition to the 2 UK EPR™ reactors, the proposed nuclear power station would have a number of features, including:

- turbines and generators which convert the thermal energy from the reactors into electricity
- a pumping station for the sea water used for condensing the steam once it has passed through the turbines
- standby diesel generators for providing power in the event of loss of grid supplies
- a radioactive waste management facility in which solid radioactive waste will be processed and packaged

- an interim storage facility for intermediate level waste in which higher activity solid radioactive waste will be stored and monitored until it can be disposed of to a dedicated waste management facility
- a spent fuel pool where spent fuel will be cooled for a period once it has been removed from the reactor core
- an interim storage facility for spent fuel in which used spent fuel will be stored and monitored once it is removed from the spent fuel pool. The fuel will be stored in a dry fuel store until it can be disposed of to a dedicated waste management facility
- electricity distribution systems, offices, workshops and welfare facilities

Figure 3.1 Simplified schematic of the EPR™ reactor



3.3. Other environmental permits

NNB GenCo (SZC) has applied to the Environment Agency for 2 other environmental permits required to operate the facility. These permits are for the discharge of cooling water and trade effluent (application reference EPR/CB3997AD/A001) and the operation of the standby diesel generators (application reference EPR/MP3731AC/A001). We consulted on all 3 of these applications at the same time.

3.4. Disposal of radioactive waste

NNB GenCo (SZC) has provided a description of the production and disposal of radioactive waste in the Head Document and Support Documents A2 and B of its application.

Radioactive waste would be produced by activities associated either directly or indirectly with operating and maintaining the nuclear reactors. The operation and maintenance of the proposed Sizewell C power station would produce solid, aqueous and gaseous radioactive waste, some of which would be discharged to the environment.

Most gaseous radioactive waste would be discharged to the environment via 2 main emission stacks, one for each reactor, at a height of 70m above ground level. Aqueous radioactive waste would be discharged with the cooling water into the North Sea via 2 outfall structures approximately 3.5 kilometres offshore. Low-level solid radioactive waste and waste oils and solvents would be transferred to off-site treatment and disposal facilities, while higher activity solid waste would be stored on-site until suitable disposal facilities are made available.

3.5. Consultation on application

We advertised and consulted on the NNB GenCo (SZC) application from 6 July to 2 October 2020, in accordance with our Public Participation Statement (Environment Agency, 2019) and the government's published consultation principles.

We carried out an equality analysis to inform our public engagement activities. We subsequently published our engagement plan for the Sizewell C's environmental permits. We will continue to monitor the effectiveness of this engagement plan as the permit determination continues.

Our consultation was open to everyone. We invited the public, the energy industry, academics with an interest in nuclear power, energy or the environment, non-governmental organisations and other organisations and public bodies to take part.

We have placed the responses to our consultation on the public register, except where the person making the response asked us not to do so. We can provide copies of documents available on public registers. We are currently transforming our public register capability to be available online, but if this service is not available at the time of any request, you can still contact us and request documents by telephone or email. We also published responses made using our e-consultation tool online on our consultation hub.

Promoting the consultation

We asked national and local stakeholders for their views on the consultation process before our consultation began. They provided feedback about their communities, the channels they use to read information and their preferred methods of engagement. We considered their responses and the extra challenges of consultation during coronavirus restrictions and published our consultation plan.

We believe that the level of local and national engagement was proportionate for the application consultation. We are confident that we did all we reasonably could and consulted properly during the period of coronavirus restrictions. We are also confident that this consultation was accessible to, and targeted at, the people and organisations it was intended for.

To raise awareness and encourage participation, we:

- emailed contacts on our stakeholder database. Our database includes national organisations and people who live near the Sizewell site such as parish and local councils, non-government organisations (NGOs), environmental groups, professional institutions, nuclear and environmental academics, the nuclear industry and trade unions

- published information and documents on GOV.UK and our e-consultation tool which hosted our documents and enabled an online response
- provided a plain English, high-level summary. In this, we were clear about the consultation process and the scope of consultation
- worked with NNB GenCo (SZC) to make copies of the application available on USB memory sticks
- updated local MPs through briefings
- advertised the consultation in local print and online newspapers (East Anglian Daily Times and the Ipswich Star), which could be read by people living near the Sizewell site in Suffolk and nationally
- issued a press release to trade, national and local media. This resulted in some coverage in print and online media
- posted information on social media (Twitter) to promote links to our consultation pages
- worked with third parties and advocates such as local parish, town and county councils, NGOs and environmental groups, securing their support to raise awareness
- added information to NNB GenCo (SZC)'s newsletters which are sent to all households in the area and an email subscriber list
- provided information about the consultation to NNB GenCo (SZC) for them to use in their communications to stakeholders and the public (such as their company newsletter)
- provided information to our staff closest to the site so they would be able to answer questions from the public in the area

To engage directly with stakeholders during consultation, we:

- organised a public question and answer session by phone. We provided speakers from the Environment Agency with expert technical knowledge. We also put in place processes to enable people to respond to the consultation over the telephone
- advertised the events widely online and sent details to our stakeholder database
- highlighted the consultation to members of the BEIS NGO forum
- informed attendees of our bi-annual nuclear regulator local engagement meetings which we hold with stakeholders in Essex and Suffolk
- provided a postal address for those who did not want to, or couldn't use email or the e-consultation tool

Appendix 1 provides further details of our consultation on the application. It also summarises the comments we received in response to our initial consultation on NNB GenCo (SZC)'s application, along with how we have considered them in coming to a proposed decision.

3.6. Further information

Although the application was ‘duly made’ (that is, we considered it was in the correct form and contained sufficient information for us to begin our determination), we requested some further information on minor issues by email and telephone. We confirmed the information NNB GenCo (SZC) provided in letters to them on 30 June 2020 and 14 January 2021. We have placed a copy of these letters on the public register as well as made them available via our consultation webpages for this proposed decision.

NNB GenCo (SZC) provided an updated Company Manual to us in January 2022. We have put this on the public register as well as made it available via our consultation webpages for this proposed decision.

4. Our assessment - part 1: General

4.1. Introduction to our assessment

In chapters 4 to 8, we set out our proposed decision based on our assessment of the application and consideration of the responses to our consultation on it. There are a number of matters we need to consider before coming to a decision on whether to grant a permit. These are addressed over several chapters, for ease of reference, and, in the main, are set out in the same order as in the application form.

In this chapter, we consider Regulatory Justification, Article 37 of the Euratom Treaty and the demonstration of competence by the potential operator.

In chapter 5, we consider how NNB GenCo (SZC) proposes to carry out the disposal of waste so as to reduce the radiological impact to members of the public to a level that is as low as reasonably achievable taking social and economic factors into account, and to protect the environment. Chapter 5 also explains how we have addressed relevant statutory requirements and government policy and guidance in relation to how the disposal of radioactive waste is to be carried out.

In chapter 6, we consider disposal routes and limits, receipt of waste, and monitoring of waste disposals and the environment.

In chapter 7, we consider the radiological impact on members of the public and the environment from the proposed discharges of radioactive waste. We also consider whether, in permitting those discharges, we would fulfil our duties across a range of environmental legislation.

In chapter 8, we consider a number of wider legal powers and duties, including that of contributing to sustainable development.

In reaching our proposed decision, we have addressed the relevant legislation, government policy and guidance, our own guidance and the responses to the public consultation on the application. Chapter 2 lists the principal documentation that describes these requirements.

Our consideration of responses to our consultation that have affected our approach or our proposed decision is set out in Appendix 1. A number of issues were raised which are outside our remit and which we have not considered in reaching our proposed decision. We have identified these issues in Appendix 1.

Appendix 2 provides a full list of Assessment Findings from the UK EPR^{TM} GDA and how they will be addressed at Sizewell C.

4.2. Justification

The Justification of Practices Involving Ionising Radiation Regulations 2004 as amended, are not part of the environmental permitting regime. Justification is a matter for government. However, we can only grant a permit if the practice is justified.

The practice is justified as the generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in a light water cooled, light water moderated thermal reactor currently known as the EPR™ designed by AREVA NP. The justification decision considers not only the activity, but the radioactive waste produced by the activity and the decommissioning required at the end of operational life. This decision can be found at Regulatory Justification decision on nuclear reactor: EPR (DECC, October 2010).

4.3. Euratom Treaty, Article 37

The UK left the European Union (EU) on 31 January 2020. Until 31 December 2020 there was a transition period during which time the UK continued to follow EU rules and regulations, including the requirements of the Euratom Treaty.

Under Article 37 of the Euratom Treaty, a member state must provide information to the European Commission relating to any plan for the disposal of radioactive waste. A submission is required, among other things, for a new nuclear facility or for a change to an existing nuclear facility that results in less restrictive authorised disposal limits. The information provided to the Commission has to be sufficient to determine whether these plans could lead to the radioactive contamination of the water, soil or airspace of another member state.

The Commission provides its opinion within 6 months, after consulting the appropriate group of experts. Until the member state receives a positive opinion, its regulatory body cannot grant an environmental permit to allow the applicant to proceed with new plans to dispose of radioactive waste.

An Article 37 submission was required for this permit application as it was made during the transition period of EU exit (see above). The submission was made on 17 August 2020 and an EU Commission opinion was subsequently provided on 3 June 2021 that the application was not liable to result in contamination of the water, soil or airspace of another member state that would be significant from the point of view of health (2021/C 221/01 (EU, 2021)).

4.4. Operator competence

Under EPR 2016, we can only grant a permit if the applicant will be the 'operator', that is, the applicant will have effective control over the operation of the facility. The Legal operator and competence requirements web guide (Environment Agency, 2016) describes what that means in more detail. Also, we must not grant a permit if we consider that the operator will not, or cannot, operate the facility in compliance with the permit.

We are satisfied that NNB GenCo (SZC) is the legal body that will have control over the operation of the facility if a permit is granted.

NNB GenCo (SZC) is a new organisation and it has applied for this permit during the design phase, many years ahead of operations beginning. Construction of the proposed new nuclear power station at the Sizewell site has not yet commenced. Subject to necessary permissions, financing and successful construction and commissioning, it is unlikely that radioactive substances activities involving the discharge and disposal of radioactive waste will begin at Sizewell C until the mid-2030s. However, we consider that there are significant benefits in regulating at an early stage of site-specific design and during the development of a potential operator's arrangements.

Successful applications early in the project allow for the development of the power station to be brought under formal regulatory control. It allows us to specify in the permit some pre-operational conditions where necessary and requirements for further information, known as information/improvement requirements. In this way, environmental matters can be considered before the detailed design is finalised and throughout procurement, construction and commissioning.

We recognise that there are a number of areas where NNB GenCo (SZC), its arrangements, and the detailed design of the facilities will be developed further. We always require that arrangements and resources are in place appropriate to each phase of a project. This helps ensure that, when permitted operations begin, the power station, its arrangements and resources are ready and suitable to maintain compliance with our permit requirements. NNB GenCo (SZC) has proposed a plan to deal with these matters in section 8.2 of the Head Document.

NNB GenCo (SZC) provided details of its management arrangements in section 7 of the Head Document as well as in the Company Manual, a Management System Manual and a RSR Compliance Matrix (in Appendix E) submitted as part of the permit application. We have assessed NNB GenCo (SZC)'s competence against the legal operator and competence requirements web guide and our guidance on Management arrangements at nuclear sites (Environment Agency, 2010b). This includes these areas where an operator should have arrangements in place:

- **organisational structure -** a suitable organisational structure for its current activities and a plan to develop an organisational structure that reflects future anticipated requirements
- **governance and environmental leadership -** arrangements to demonstrate that clear environmental leadership, direction and control is established through the organisation
- **management system implementation -** arrangements to demonstrate evidence of management system implementation that is adequate for the current stage of the project and how it will develop to meet future needs
- **environmental capability -** sufficient trained and competent persons and resources to support its current environmental management activities and be

capable of developing this resource to meet changes to environmental activities carried out at the proposed site
- **change control and living management arrangements -** arrangements to be able to demonstrate how the impact of organisational and other changes is assessed in terms of environmental impact and permit compliance

Our assessment is discussed in more detail in sections 4.4.1 to 4.4.8, but our overall conclusion for the current stage of NNB GenCo (SZC)'s development, is that it will be able to operate in accordance with the draft permit.

NNB GenCo (SZC) has included a commitment regarding organisational capability and arrangements development as part of the plan outlined in section 8 of its application's Head Document. We have included an information/improvement requirement, IC 1, in the draft permit that requires NNB GenCo (SZC) to provide an annual progress report on organisational development.

4.4.1. Organisational structure

We have assessed the NNB GenCo (SZC) organisational structure for its capability in terms of resources and competence to understand the environmental hazards of its activities and promote successful environmental management of waste, both radioactive and non-radioactive, throughout all phases of the project.

The current structure of NNB GenCo (SZC) is outlined in the Company Manual included with the application. Further details of the company's structure are also provided in the NNB GenCo (SZC) Nuclear Baseline document (and subsequent revisions) included in the Nuclear Site Licence application made to the Office for Nuclear Regulation in June 2020. We are satisfied that it reflects the work being carried out, has been informed by our guidance and shows clear lines of control and allocation of responsibilities.

We are satisfied that relationships and interfaces between NNB GenCo (SZC) and the parent companies and other organisations (for example, NNB GenCo (HPC) and companies and divisions from the EDF Group) are clearly defined. We are also satisfied that there is governance in place to ensure that NNB GenCo (SZC) has the appropriate level of autonomy, while also recognising its links to other organisations such as NNB GenCo (HPC), EDF and the EDF SA group of companies. This includes the arrangements that NNB GenCo (SZC) has such that it can demonstrate sufficient knowledge of the proposed plant and that it is able to ensure that BAT is incorporated within the design and operational techniques.

We have noted changes to NNB GenCo (SZC)'s organisational structure in response to business needs during our determination of the application to date. These have been outlined within an update of the NNB GenCo (SZC) Company Manual that was provided to us in January 2022 as outlined in chapter 3.

The Nuclear Energy (Financing) Act (UK Parliament, 2022) was passed by Parliament in April 2022, this makes provision for the implementation of a Regulated Asset Base (RAB) model for nuclear generation projects. If the RAB model is applied to the Sizewell C project, then there may be implications for NNB GenCo (SZC)'s organisational and governance structures. We will work with the Office for Nuclear Regulation on the implications of any planned changes in these areas to ensure they meet regulatory requirements and expectations.

NNB GenCo (SZC) has set up committees such as the Sizewell C Organisational Capability Committee to ensure its senior management is monitoring the effectiveness of its organisational structure and to utilise learning from the Hinkley Point C project. It also has a Nuclear Safety Committee (as required by Licence Condition 13 of a Nuclear Site Licence) to advise and challenge on all matters across NNB GenCo (SZC) that may affect nuclear safety or radiological matters on or off the nuclear licensed site.

NNB GenCo (SZC) has identified nuclear and environmental organisational baselines, identifying those posts within the organisation that can impact nuclear safety and environmental management respectively. These posts are assigned role training profiles, setting out competency requirements for the individual posts. Post holders are assessed against the role training profiles to confirm they have the required skills and knowledge to undertake their roles. The baselines are subject to a formal ongoing process to identify further posts, skills and training requirements as the company develops.

NNB GenCo (SZC) has provided in its application clear evidence within the definitions of the posts of how technical and governance responsibilities are assigned and flow through the organisation. We consider this to be sufficient at this time, but we will monitor this as the organisation develops.

NNB GenCo (SZC) sets out in the Head Document of its submission and in the Nuclear Baseline document, how the organisation will develop in the future, the timescales for the different phases of the construction, and how the organisation would be developed to meet these requirements. We have reviewed the proposals and consider that NNB GenCo (SZC) can develop the necessary capabilities at a site level as the project progresses.

NNB GenCo (SZC) sets out in section 7 of the application's Head Document how it plans to develop its approach to incidents. With regards to investigating incidents it plans to replicate those arrangements currently in place at Hinkley Point C. These arrangements are currently being developed by NNB GenCo (SZC) and we are engaging with the company along with ONR who will regulate this aspect through Licence Condition 7 of a nuclear site licence.

4.4.2. Governance and environmental leadership

We have assessed how the management arrangements are helping drive the development of an environmental protection culture, and how senior management is providing effective leadership so that environmental values and behaviours are developed within the organisation.

NNB GenCo (SZC) has an Environment Policy statement signed by the Managing Director. It identifies that the Head of Environment, Decommissioning and Radiation Safety is responsible for the maintenance and implementation of the policy. The NNB

GenCo (SZC) Environment Policy statement states that the policy is implemented through line management.

NNB GenCo (SZC) has identified that the NNB GenCo (SZC) Board has responsibility for safety and environmental management and is ultimately accountable for all safety, environmental and security related decisions. NNB GenCo (SZC)'s Company Manual also sets out the individual Board members' environmental responsibilities. NNB GenCo (SZC) has a Nuclear Safety Committee (NSC) which performs an important governance role on important nuclear and environmental issues and decisions. Furthermore, an Independent Nuclear Assurance team provides independent challenge to the organisation on safety and environmental matters and reports to the Board through the Safety, Licensing and Assurance Director. We are satisfied that these arrangements will provide an adequate level of direction and accountability on environmental matters.

NNB GenCo (SZC) has also provided details on supporting committees and their terms of reference. We are satisfied that there is sufficient information to give us confidence that these committees should be able to inform the NNB GenCo (SZC) Board and challenge where appropriate.

NNB GenCo (SZC) maintains a Nuclear Baseline document to support its Nuclear Site Licence application. This identifies where directors and other members of the organisation have key roles in respect to nuclear safety, including radioactive substances permit compliance. In addition, the Nuclear Baseline also identifies where certain posts are required as an in-house capability that has knowledge and understanding of the products and services to be supplied/procured. These posts fulfil the 'Intelligent Customer' roles with respect to nuclear safety and radioactive substances permit compliance.

NNB GenCo (SZC) is developing a comprehensive training programme to ensure that directors understand their environmental responsibilities, are competent to fulfil them and that there is a programme of continual improvement. Training and competency assessments for other posts will be tailored to the defined roles that they will undertake. These training requirements are to be replicated from or developed in conjunction with NNB GenCo (HPC) Ltd.

4.4.3. Management system implementation

We recognise that the management arrangements being developed can only be implemented for the current work being carried out. At the time of application, this relates to site-specific design, site investigations, development of the operational organisation and procurement.

NNB GenCo (SZC) has provided information in section 7 of the Head Document, in the Management System Manual and the RSR Compliance Matrix on the strategy and development of the management arrangements for permit compliance at each stage of the construction, commissioning and operation of the plant.

NNB GenCo (SZC)'s Management System Manual describes how the management processes for NNB GenCo (SZC) are to be implemented. It includes a diagram (Figure 1 in the document) showing the hierarchy of documents it intends to produce as part of an integrated management system.

The RSR Compliance Matrix outlines the compliance approach and describes the expected arrangements to be in place to comply with permit requirements (for example, BAT, monitoring and sampling, keeping records) for different phases of the station's development (prior to construction phase, construction phase and active commissioning phase).

We have examined the proposed approach and are satisfied that the important activities have been identified, and that regulatory commitments can be met. We are satisfied that there will be adequate identification of systems and equipment relevant to the permit, and that there is adequate configuration control of those systems to ensure design development incorporates assessment of BAT.

NNB GenCo (SZC)'s application outlines its plans to replicate, wherever possible, management arrangements from Hinkley Point C. We are working closely with ONR in scrutinising NNB GenCo (SZC)'s development of its management arrangements and are content that they are adequate for the current stage of activities regarding environmental protection matters. Through these interactions with NNB GenCo (SZC) and ONR, we have seen evidence of the progress of the review and adoption of these procedures via a tracking system and evidence of implementation. Updates on progress are regularly provided to us via the regular engagements that we and ONR are having with the company.

NNB GenCo (SZC)'s commitment to develop the management arrangements for future phases of the project are outlined in section 7 and in the plan in section 8 of the application's Head Document. We are satisfied that delivery of this plan is likely to produce adequate written arrangements, where they are not essential at this phase of the project. As part of our regulatory activities, we will carry out assessments of these arrangements in order to determine their adequacy.

NNB GenCo (SZC), with assistance from EDF's Nuclear Skills Academy, is currently implementing systems and arrangements to identify training and competence requirements for suitably qualified and experienced persons (SQEP). These arrangements are also to be applied to NNB GenCo (HPC)'s Hinkley Point C site and the EDF Energy Nuclear Generation sites, so that all 3 operators have a consistent approach. This is expected to provide benefits if staff transfer between the 3 operators.

As part of our determination activities we have considered the adequacy of the developing NNB GenCo (SZC) arrangements to draw on support from its sister companies. These include NNB GenCo (HPC) Ltd, EDF Energy Nuclear Generation Ltd and the Technical Services Organisation described in the NNB GenCo (SZC) Company Manual accompanying the application. These arrangements are currently being developed and we are maintaining our engagement with NNB GenCo (SZC) on these matters to ensure the organisation has access to the necessary resources and operational experience from Hinkley Point C and the EDF Energy operational nuclear power stations.

We have placed a requirement in the draft permit for NNB GenCo (SZC) to provide an annual progress report on the organisational development relevant to permit compliance. This requirement is referenced as IC 1 in the draft permit. We will use this report as well as our inspections to monitor progress against commitment 2 of NNB GenCo (SZC)'s forward action plan (found in section 8 of the application's Head Document).

4.4.4. Environmental capability

As set out in our RSR generic developed principles: regulatory assessment (Environment Agency 2021b) and specific draft permit requirements, we expect NNB GenCo (SZC) to have sufficient trained and competent persons and resources, to secure and maintain proper protection of people and the environment, to support its current environmental management activities and be capable of developing this resource to meet changes to environmental activities carried out at the proposed Sizewell C site.

We have reviewed the developments NNB GenCo (SZC) made of its arrangements for core environmental competencies and how it will maintain the ability to put these environmental skills and knowledge into practice to the high standard we expect. We believe these to be adequate for this stage of the project.

NNB GenCo (SZC) has developed 2 baseline documents. A baseline reflects the minimum staffing, skills, competencies and capabilities required at any given stage of a project. NNB GenCo (SZC) has opted to develop a Nuclear Baseline to demonstrate nuclear and radiological safety, including radiation protection, radiological environmental protection, security and quality (insofar as it supports the delivery of these). The Nuclear Baseline is designed to meet ONR requirements and those of the EPR-RSR permit.

NNB GenCo (SZC) has also developed a wider environmental baseline that addresses the needs of the EPR-RSR permit and other EPR permits for water discharges, combustion and other environmental aspects. The baseline document identifies important current and future posts with environmental responsibilities against the various defined environmental roles that these posts will carry out. It identifies the necessary role types and numbers of staff that NNB GenCo (SZC) predicts it will need for both the current and future stages of the project. Roles that are essential for RSR permit compliance are also recorded on the Nuclear Baseline. NNB GenCo (SZC) has introduced management of change governance arrangements that link changes to the Nuclear and Environmental Baselines or their arrangements, to the RSR permit's requirement to notify us in advance of changes if these might, or might be seen to have, a potential impact on how compliance with the conditions of the permit is achieved. We are satisfied that the arrangements for creating and managing the baseline documents are adequate.

We have considered, as part of the determination process and our assessment of the NNB GenCo (SZC) Corporate Radioactive Waste Adviser application (see section 4.4.5), the processes it is using to identify specialist environmental roles and the training and development plans proposed to support their development.

NNB GenCo (SZC) is developing a training system that identifies the environmental knowledge and responsibilities of both NNB GenCo (SZC) staff and its contractors. This is based on the arrangements used at Hinkley Point C. We and ONR are currently engaging with NNB GenCo (SZC) on how the training system is being implemented in the company.

NNB GenCo (SZC) resource requirements are set out in a Sizewell C specific Resourcing Strategy. This sets out NNB GenCo (SZC)'s approach to understanding and developing the workforce required to carry out the range of project activities and responsibilities for Sizewell C, including future operations.

Following our review of these arrangements and documentation, we consider the level and capability of the resources within NNB GenCo (SZC) to be appropriate for this stage of its activities. We also consider that it has adequate arrangements and plans to ensure it has the appropriate capability for the next stage of the project.

We will request regular updates and monitor progress of NNB GenCo (SZC)'s environmental capability as the project progresses.

4.4.5. Environmental capability - Radioactive Waste Advisers

In EPR 2016 there is a requirement that the Environment Agency ensures that permit holders are required to seek advice from Radioactive Waste Advisers (RWA) regarding the arrangements for the disposal of radioactive waste. The use of suitable RWAs is to ensure that appropriate measures are in place to achieve and maintain an optimum level of protection of members of the public from a permit holder's disposals.

This requirement for permit holders to seek advice from RWAs is a condition (1.1.5) of the draft permit:

"The operator shall:

(a) manage and operate the activities in consultation with one or more suitable Radioactive Waste Advisers for the purpose of advising the operator as to compliance with this permit

(b) appoint the Radioactive Waste Adviser(s) in writing, including the scope of advice they are required to give"

The Radioactive Waste Adviser scheme was developed jointly by the Scottish Environment Protection Agency (SEPA), the Environment Agency, Natural Resources Wales and the Northern Ireland Environment Agency. Details of how the RWA scheme is implemented can be found in the environment agencies' Statement on radioactive waste advisers (Environment Agency and others, 2018b), which was revised in October 2018. This provides detailed guidance on how permit holders may comply with the RWA requirement, including the use of a Corporate Radioactive Waste Adviser body (CRWA).

NNB GenCo (SZC) made an application for recognition of its CRWA arrangements in January 2021. The application was assessed and the arrangements were subsequently approved by the Radioactive Waste Adviser Board in March 2021. Although this process is independent of this application, it provides supporting evidence of the adequacy of arrangements and resource available to NNB GenCo (SZC) in this area.

4.4.6. Change control and management arrangements

We recognise that NNB GenCo (SZC) is a developing organisation. By issuing the permit at an early stage in its development we will maintain a proportionate degree of regulation at each stage of the project. This will ensure that management arrangements are developed that will support good environmental outcomes when the plant is in operation.

NNB GenCo (SZC) has provided information on how the change process for organisational and design changes are embedded into its management system, so that there is oversight and governance of any proposed changes at a level appropriate to the environmental risk.

We consider it important that the developing management arrangements are subject to a change control system that is rigorous and provides an organisation that can meet the relevant requirements of the permit at all stages of the project. Arrangements for reviewing and changing the management system documentation have been developed. NNB GenCo (SZC) procedures have a maximum period of 3 years between reviews, and this is monitored by the appropriate governance group.

NNB GenCo (SZC) has several working groups which are overseeing different aspects of the management arrangements being put in place. This includes a Permitting and Licensing Oversight Group, an Integrated Management System Review Panel and a Management System Governance Group (run jointly with NNB GenCo allowing sharing of operational experience from Hinkley Point C). We are continuing to engage with NNB GenCo (SZC) in this area to ensure that our expectations are met.

NNB GenCo (SZC) is seeking to replicate the EPR reactor design and plant configuration that is under construction at its sister company's site at Hinkley Point C. NNB GenCo (SZC) has provided information in section 7 of the Head Document on how it intends to control design changes for their potential impact on environmental performance. Some changes will be required to the Hinkley Point C configuration and systems for use at Sizewell C to account for the local environmental conditions. As part of our engagement with NNB GenCo (SZC), we have reviewed evidence that these types of design/configuration changes are being appropriately assessed, managed and considered.

Based on our review of modifications undertaken to date, we are satisfied that the proposed arrangements are adequate for this stage of the project. We are also satisfied that NNB GenCo (SZC)'s system provides us with adequate notice of any significant changes and, as the project progresses, would maintain adequate records of changes for us to review.

4.4.7. Readiness review

NNB GenCo (SZC) plans to carry out a 'readiness review' as part of its arrangements prior to moving to the next defined phase of the project. These 'readiness reviews' are carried out to reassure NNB GenCo (SZC) that its management arrangements are sufficient to meet its requirements for the next stage of the project.

We expect that such a ‘readiness review’ will be carried out prior to our final decision on issuing a permit. As part of our final determination of the application, we will assess this ‘readiness review’ to assess the adequacy of NNB GenCo (SZC)’s arrangements. We will also carry out our own inspections of the readiness of NNB GenCo (SZC)’s arrangements where we feel this is necessary. The outcome of our assessment of the readiness reviews, our own inspections, along with the responses to this consultation and any other relevant matters will be considered as part of our final decision.

4.4.8. Conclusion

We have assessed NNB GenCo (SZC)’s organisational structure, governance and leadership, management system implementation, environmental capability, and change control arrangements and find them to be adequate for the current stage of the project.

5. Our assessment – part 2: The use of the best available techniques for the management and disposal of radioactive waste

Under EPR 2016 (Schedule 23), we have a duty to ensure that 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 (ALARA), taking into account economic and social factors.

We do this by requiring the operator to use best available techniques (BAT) in the operation of the facility to:

- prevent and minimise (in terms of radioactivity) the creation of radioactive waste
- minimise (in terms of radioactivity) discharges of gaseous and aqueous radioactive waste
- dispose of radioactive waste at time, in a form, and in a manner that minimises the radiological impact on the environment and the public
- minimise (in terms of mass and volume) solid and non-aqueous liquid radioactive waste

'Operation' covers the full lifecycle of a facility, including its design, build, commissioning, operation, maintenance, decommissioning and waste disposal.

We require the operator to dispose of solid and non-aqueous liquid wastes by optimised routes (taking account of the waste hierarchy and the proximity principle).

The best available techniques are required for minimising waste creation (for example, by avoiding activation or contamination of materials, and taking opportunities to reuse or recycle materials that might otherwise be disposed of as waste); abating discharges; and monitoring of plant, discharges and the environment. It takes account of several factors, including the availability and cost of relevant measures, operator safety (including worker doses), and the benefits of reduced discharges and disposals.

What constitutes BAT in any given circumstances is subject to technological development, effectiveness of the technique, feasibility of modification, legal and policy changes. We recognise that BAT will depend on the balance of a number of factors at any given time or stage in a facility's life and it may change over time. We require operators to keep these factors under review and to be able to justify the application of BAT at any time.

We require operators to ensure that their discharges are minimised and below the permitted limits that we set so as to properly protect people and the environment. This also ensures that radiation dose limits and constraints, and guideline exposure levels for wildlife, are not exceeded. We require operators to ensure that the radiation exposure of people from discharges is as low as reasonably achievable (ALARA), taking social and economic factors into account (optimisation) by applying BAT. This requires balancing the relevant factors (detriments, costs and benefits) to arrive at an optimised solution.

For any wastes created for which there is no currently available disposal route, that is intermediate level waste (ILW) and high level waste (HLW), NNB GenCo (SZC) must also demonstrate:

- their suitability for eventual disposal
- how they will be managed, in the interim, so as not to adversely affect their suitability for ultimate disposal

We have taken full account of the work we have done during GDA, so that our assessment is focused on operator and site-specific matters, including how NNB GenCo (SZC) has made progress addressing Assessment Findings arising from our GDA of the UK EPR™.

We have also taken into account design developments and implementation plans that have occurred at the Hinkley Point C EPR™ project since the GDA process was completed, as the Hinkley Point C EPR™ design is the reference design for Sizewell C.

5.1. How NNB GenCo (SZC) has identified BAT

We expect operators to identify BAT by a method that is timely, transparent, inclusive, based on good quality data and properly documented. The method should demonstrate that a new plant uses BAT and that it can be applied to continually review BAT throughout the lifetime of the plant to identify whether upgrades or modifications may be required based on operational experience or the availability of newly developed techniques.

We assessed BAT for the UK EPR™ in our GDA and, in December 2012, we issued a Statement of Design Acceptability (SoDA). Our decision is documented in our 2011 UK EPR™ decision document and 2012 Supplement to the Decision Document. We confirm that it is valid for NNB GenCo (SZC) to use the outcome of GDA to support its demonstration of BAT for the Sizewell C EPR™ reactors.

NNB GenCo (SZC) has described its approach to identifying BAT in the Environment Case (Support Document A1) submitted as part of the permit application, specifically in chapters 2 and 3. NNB GenCo (SZC) uses a structured approach which uses claims, arguments and evidence (CAE) to demonstrate the application of BAT in the Environment Case[1].

[1] An Environment Case, often referred to as a BAT case, is a document produced by the operator and submitted to the Environment Agency as part of the permit application. The Environment Case will describe how a BAT assessment process has been applied to the design and how it has been optimised to protect the environment; the Environment Case will include evidence to support the arguments made.

We have assessed the information provided in the Environment Case and consider that NNB GenCo (SZC) has an appropriate method to identify and review BAT throughout the lifetime of the plant and that this meets our expectation with our Radioactive Substances Management Developed Principle 4 (RSMDP4), regarding a methodology for identifying BAT in our Radioactive substances management: generic developed principles.

A summary of the approach NNB GenCo (SZC) used to identify BAT is as follows.

NNB GenCo (SZC)'s Environment Case summarises the main requirements for demonstrating BAT, clearly identifying the requirements of the Environment Agency's guidance RSR Principles of Optimisation. The document states that BAT would be applied throughout the lifecycle of the power station, from design through operations, decommissioning and site restoration as we would expect.

An important part of the Sizewell C Environment Case is its intention to use a 'replication strategy' which is presented in section 1.3 of the Environment Case, and a BAT justification for this approach is made in section 2.3. The Environment Case states that the replication strategy is to replicate the design of Hinkley Point C at Sizewell C as far as practicable. The BAT justification for the Sizewell C design is therefore based on the arguments made for Hinkley Point C; where site-specific impacts and design changes from the Hinkley Point C design have been incorporated, these have been assessed to ensure the BAT justification remains valid.

Section 3.3 of the Sizewell C Environment Case identifies some of the site-specific differences that need considering at Sizewell C. These include the height of discharge stacks, cooling water outfall tunnels and the location of waste storage facilities for spent fuel and intermediate level waste (ILW). These site-specific differences are addressed in information provided in the Environment Case sections 6.4.5, 6.4.3 and 6.2.6 respectively.

We have assessed the arguments NNB GenCo (SZC) made to apply the replication strategy and will continue to monitor its application. We accept that there are potentially significant benefits in replicating an established design at another site, provided that NNB GenCo (SZC) continues to demonstrate that:

- the benefits of replication contribute to BAT
- any advances in technology have been considered and reasons for or against adopting them are explained
- compliance with any changes in environmental legislation that have occurred since the original design
- the impact of design changes are considered and assessed
- Sizewell site-specific requirements are considered and assessed

The replication strategy provides significant benefits to the Sizewell C project by taking the design and lessons learned from Hinkley Point C and applying them to Sizewell C. This is potentially a more efficient way of building Sizewell C and allows the BAT arguments developed at Hinkley Point C to be applied at Sizewell C.

We expect NNB GenCo (SZC) to learn from the Hinkley Point C project and from the wider industry in line with our Management and Leadership Developed Principle 5 (MLDP5) regarding learning from experience in our Radioactive substances management: generic developed principles. In section 2.4 of the Environment Case, NNB GenCo (SZC) provides information on how this is achieved by sharing learning and operational data between EDF's UK based reactor fleet, including the Sizewell B PWR, and EDF's PWR Fleet in France. Further examples of learning provided include membership of the Electric Power Research Institute (EPRI).

NNB GenCo (SZC) has presented its BAT arguments in the Environment Case following a claims, arguments, evidence (CAE) structure, where:

- **claim** is a statement of what is being sought in terms of environmental outcome or optimisation
- **argument** is an element which contributes to achieving a claim
- **evidence** is information demonstrating the validity of arguments and claims

The CAE methodology is used widely in safety case demonstration and recognised by regulators as a valid systematic approach. It is the same approach NNB GenCo (HPC) used at Hinkley Point C to demonstrate BAT. We accept this approach as it provides a clear and logical link between our permit conditions for the application of BAT.

The 5 claims NNB GenCo (SZC) made in the Environment Case are:

- **claim 1:** NNB GenCo (SZC) shall eliminate or reduce the generation of radioactive waste
- **claim 2:** NNB GenCo (SZC) shall minimise the amount of radioactivity discharged or disposed of to the environment
- **claim 3:** NNB GenCo (SZC) shall minimise the volume of waste disposed to other premises
- **claim 4:** NNB GenCo (SZC) shall minimise the impacts on the environment and members of the public from radioactive waste that is discharged or disposed of to the environment
- **claim 5:** NNB GenCo (SZC) shall undertake appropriate monitoring to check compliance with the conditions of the RSR permit

The claims identified are consistent with the requirements of the draft RSR permit and our associated guidance, including How to comply with your RSR Permit, with each claim underpinned with arguments and supporting evidence, presented in the Environment Case.

In section 3.2 of the Environment Case, NNB GenCo (SZC) explains that the Sizewell C BAT arguments are an evolution of the Environment Case presented for Hinkley Point C since the baseline design of Sizewell C (described as Reference Configuration – 'SZC RC 0') is based on the latest Hinkley Point C design (Reference Configuration 2 – 'HPC RC2'). NNB GenCo (SZC) identified 5 important steps in developing the BAT arguments for the Sizewell C Environment Case. These were:

1. **develop**. Explore the techniques available and determine the contribution that they will make to optimising environmental performance. This is expected to draw heavily on the evolutionary nature of the UK EPR™ design and associated operational experience from the EDF fleet of nuclear reactors
2. **specify**. Apply decision-making processes to select the technique(s) and specify accordingly
3. **implement**. Undertake activities to implement specified techniques.
4. **verify.** A check is undertaken to verify that the chosen technique has been implemented in accordance with the specification
5. **review.** The performance of the chosen technique is reviewed to ascertain the degree to which it meets expectations. This, in turn, is fed back into organisational learning and management

NNB GenCo (SZC) would apply the replication strategy and reproduce the Hinkley Point C design at Sizewell C as far as possible. However, as part of ongoing regulation, we would require NNB GenCo (SZC) to provide evidence that the BAT arguments remain up to date in line with changing technology and policy.

NNB GenCo (SZC) identified that Steps 3 and 4 of the development of the BAT arguments would take place during the construction and commissioning phases. During this period, we would require evidence that the BAT requirements in the Environment Case have been met in our inspection activities and review of responses required to permit information/ improvement conditions.

NNB GenCo (SZC) provided information in the Sizewell C Environment Case on the assessment and identification of environmental protection functions and the structures, systems and components that provide them. During the GDA process for the UK EPR™ we identified the following Assessment Finding (UKEPR-AF21):

“Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CC-01) used for categorising safety function and classifying structures, systems and components (SSCs) has been applied to relevant SSCs that deliver an environmental protection function.”

We consider that the approach described in the Sizewell C Environment Case replicates the approach taken at Hinkley Point C in the creation and maintenance of an Environmental Protection Function Register, and that this satisfies the requirement of UKEPR-AF21. We are aware through our interactions with NNB GenCo (SZC) that work is underway by NNB GenCo (SZC) to assess the Hinkley Point C Environmental Protection Function Register and to identify where additional information is required, to ensure it is suitable for Sizewell C to adopt. The development of the Environmental Protection Function Register at Sizewell C would be an important focus of our future regulation of the site.

5.2. BAT to prevent or minimise the creation of radioactive waste

The generation of electricity using the heat produced by nuclear fission of uranium in a nuclear reactor gives rise to radioactive wastes containing fission products. We assessed the NNB GenCo (SZC) approach to the containment of these wastes, and the minimisation of the generation of other radioactive wastes, including actinides and those created as a result of neutron activation.

We assessed this topic as part of our GDA assessment of the UK EPR™ (see chapter 8 of our UK EPR decision document). We have confirmed that NNB GenCo (SZC) intends to use the same techniques presented in GDA and, therefore, we repeat our conclusions from GDA. We produced Assessment Findings in GDA and where these have not been closed out, we have included improvement conditions in the draft permit.

NNB GenCo (SZC) set out its case for this topic in sub-chapter 6.1 section 2 of the Environment Case as "Claim 1: SZC Co. Shall Eliminate or Reduce the Generation of Radioactive Waste". It submitted information under 8 arguments that address:

1. fuel design
2. fuel efficiency
3. failed fuel
4. specification of materials
5. primary coolant chemistry
6. start-up and shutdown
7. secondary neutron sources
8. development of management procedures/operational controls

A summary of the submission NNB GenCo (SZC) made is as follows.

In section 6.1 of the Environment Case, NNB GenCo provided information on the 4 principles it used to guide the minimisation of radioactive waste in the design of the reactor, which are described as:

- specification of materials of construction for the reactor and the nuclear steam supply system (NSSS) to minimise the unnecessary creation and movement of activation products during power generation
- provision of systems to manage and optimise the chemistry of the primary coolant circuit to minimise the generation of radioactivity through activation of elements in the primary coolant (including corrosion products) that will subsequently become radioactive waste
- the design, manufacture and management of nuclear fuel, including fuel cladding to minimise the release of fission products, tritium and actinides into primary coolant
- design of engineered systems to limit activation of materials and contain radioactivity as close to the point where it is created; to limit its movement and migration through process and plant; and to minimise the generation of secondary wastes

We have reviewed the arguments and supporting evidence and summarised our findings:

Argument 1 addresses the design, manufacture and management of fuel to minimise generation of radioactive wastes. NNB GenCo (SZC) identified the main components that minimise the radioactivity generated within the nuclear fuel escaping the fuel cladding and entering the coolant. We noted that the final choice of fuel has yet to be made, so once this is made, we will need to check that this meets our expectations from the GDA, namely that fuel assemblies should exhibit consistently high operational reliability to minimise generation of radioactive waste. We have included an information/improvement condition IC 13 in the draft permit for NNB GenCo (SZC) to provide evidence that the design, manufacture and management of fuel will be suitable to meet our expectations.

Argument 2 is supported by evidence that the UK EPR™ maximises efficiency of fuel use. We confirm that the information presented is essentially the same as presented for GDA and the Hinkley Point C permit application and we accept the argument.

We have sought further information from NNB GenCo (SZC) regarding its approach to specifying what normal operation includes and the impacts of the Grid Code[2] requirements to be able to respond to frequency deviations, to load-follow[3] or to de-rate[4] to maintain grid stability. Nuclear power stations in the UK have rarely been asked to undertake the latter of these operations. Operation has been primarily as 'base load' provision. We sought reassurance that the assumptions made underpinning the application and that the impacts of any foreseeable Grid requirements during the station lifespan would not challenge the BAT case, waste arisings or impacts reported in the application. We discuss this further in section 6.1 of this document.

Argument 3 covers the detection and management of failed fuel. The design uses the experience from the current PWR fleet operated in France by EDF and incorporates operational feedback from existing performance monitoring programmes.

Management of failed fuel refers to the prudent preparation for a small number of fuel pins that may have defects in the fuel cladding that allow the migration of radioisotopes from the fuel into the primary coolant. The Sizewell C design anticipates these events occurring and is designed to operate with a defined small but tolerable number of failed fuel pins. Contamination of the primary circuit as a result of failed fuel is mitigated by the waste

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2 The Grid Code sets out the requirements stipulated by the National Grid which must be met by a power generator to allow it to connect to the national grid. The code is maintained by National Grid ESO and approved by the Energy Regulator Ofgem. https://www.nationalgrideso.com/industry-information/codes/grid-code.

3 Load-following is where a power plant adjusts its power output to match the demand for electricity.

4 Derating is where a power plant operates at less than its normal capability to meet a reduced demand for electricity.

management arrangements, and we recognise these are designed to minimise the discharges to the environment. Our permit requires the operator to minimise the production of radioactive waste during the operation of the reactor. When failed fuel is detected we expect the operator to inform us and to be able to justify that BAT is being applied.

Monitoring for failed fuel is continuously carried out by measuring increases in fission product in the reactor coolant, primarily of the ratio of gaseous isotopes xenon-133 and xenon-135. Should an increase in fission products be observed, actions can be taken, ranging from increased surveillance through to reactor shutdown. NNB GenCo (SZC) has defined maximum levels of fission product contamination in the primary coolant as a result of failed fuel. Continued operation with any failed fuel in the reactor is limited to a maximum of 18 months after which routine refuelling occurs. Contamination from failed fuel exceeding predefined levels will result in the reactor being shut down for failed fuel removal in advance of the 18-month routine cycle period. NNB GenCo (SZC) will not permit a new fuel cycle to start containing failed fuel, and therefore fuel with suspected defects would be tested and would be removed during the routine refuelling shutdown.

We accepted the argument regarding the reasonable foreseeability and impacts of failed fuel in GDA and at Hinkley Point C. Based on the operational experience of the PWR fleet in France, the discharge envelope applied for includes allowance for very limited fuel failure. NNB GenCo (SZC) states that the Sizewell C design anticipates these events occurring and is designed to operate with a small number of failed fuel pins, provided the fission product in the primary coolant does not exceed specified activity limits.

Since NNB GenCo (SZC) made its permit application, 3 EPR™ reactors have undergone active commissioning with two of these entering commercial operation: 2 units at Taishan in China are in commercial operation and one at Olkiluoto in Finland (one unit) is in commissioning. In June 2021, one of the reactors at Taishan (Unit 1) was reported to have suffered performance issues relating to leakage of radioactivity from fuel rods into the primary circuit. NNB GenCo (SZC) wrote to us in May 2022 to update us on this matter and provide a summary of the root cause of the Taishan issue, as well reaffirming its commitment to learning from experience. It included a letter from Framatome, the fuel manufacturer for the Taishan plant, advising that the fuel leaks were due to failure of springs in the fuel assemblies and setting out how it had resolved this issue. The mitigation measures outlined in the letter provide reassurance that the learning from Taishan will be applied to other UK EPR™ sites such as Sizewell C and Hinkley Point C. We will continue to engage with NNB GenCo (SZC) on this topic so that we have reassurance that the measures proposed are implemented. Where operational experience at other EPR™ sites provides learning that can be applied to Sizewell C (and Hinkley Point C), our expectation is that it will be applied at both sites and in accordance with BAT.

The proposals to detect, remove and store failed fuel assemblies were accepted at GDA and for the Hinkley Point C permit application. We can confirm that we have not identified any new technological developments or operational experience that would change our assessment that these remain acceptable.

Argument 4 details the specification of materials to minimise the activity and generation of radioactive waste. The arguments provided address 2 issues:

- the neutron activation of materials that have corroded from the internals of the reactor coolant system which are activated as they pass through the reactor
- the activation of structural materials in and close to the reactor core

NNB GenCo (SZC) identifies a number of methods to minimise activation, including minimising the use of materials that are readily activated. These include minimising hard cobalt/chromium alloys known as Stellite™, which are a potential source of cobalt-60 as a result of neutron activation. Other methods include selecting materials that reduce corrosion and pre-conditioning surfaces.

The pre-conditioning processes considered are electro-polishing and a chromium coating process that provide a surface coating to reduce the cobalt release rate and reduce surface contamination.

A requirement for further review work to be completed on the minimisation of activated corrosion products was identified as a GDA Assessment Finding UKEPR-AF04 for the UK EPR™. This Assessment Finding was included in the Hinkley Point C RSR permit as information condition/improvement 8. The information/improvement condition required further evidence that corrosion products have been minimised in the following areas:

- the corrosion resistance of steam generator tubes
- the electro-polishing of steam generator channel heads
- the specification of lower cobalt content reactor system construction materials
- the use of Stellites™ in reactor components, in particular the coolant pumps

The Sizewell C Environment Case identifies that the work described above is applicable to the Sizewell C design and NNB GenCo (SZC) has provided this information in the Environment Case, section 6.1.4. We consider this information addresses GDA Assessment Finding UKEPR-AF04 for the current design phase. We consider that a focus on minimising production of activated corrosion products should continue throughout the procurement, commissioning and construction phases of the development and this is addressed through information/improvement condition (IC 2) in the draft permit.

Argument 5 concerns optimisation of primary coolant chemistry to minimise the production of radioactive waste. Control of the primary coolant chemistry is required to:

- provide a neutron absorbing chemical shim using ‘burnable poisons[5]’ to control core reactivity throughout the fuel cycle, or to damp reactivity in emergency conditions

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[5] Burnable poisons or burnable absorbers are materials that absorb neutrons, ‘poisoning’ or reducing core reactivity. They are converted to materials of low absorption by neutron capture. This process is referred to

- maintain the fuel integrity and ensure that the radioisotopes generated in the fuel are retained within the fuel cladding
- minimise the corrosion of metal surfaces; this maintains the integrity of the primary circuit, reducing redundant components as waste. Use of zinc injection reduces the rate of corrosion and the deposition of activated corrosion particles around the reactor systems and lithium hydroxide injected into the primary coolant maintains a specific pH range which reduces corrosion
- maintain the primary coolant pH while minimising the production of tritium. The use of boric acid that is enriched with the neutron absorbing isotope boron-10 reduces the amount of lithium hydroxide necessary to maintain the correct pH. Lithium that is depleted in the isotope lithium-6 further reduces tritium production. The use of gadolinium (another burnable poison neutron absorber) in the fuel reduces the amount of boric acid that must be added to the coolant, therefore reducing tritium discharges further
- control of the dissolved gases in the coolant which are neutron activated to produce carbon-14 and tritium

The overall approach to chemistry control was accepted during GDA with one Assessment Finding (UKEPR-AF05) that required the operator to assess the impact of zinc injection on radioactive waste generation. This was included as information/improvement condition IC 2 in the Hinkley Point C RSR permit and will need to be addressed at Sizewell C. We have included this as part of the requirement IC 13 of the draft permit. NNB GenCo (SZC) has identified this action as a forward action in Commitment 12 of the application: ”SZC Co. will develop its chemistry specifications (covering commissioning, start-up and shut down, as well as normal operations), demonstrating that the generation of corrosion products is as low as reasonably practicable (ALARP).”

Argument 6 relies on procedures during commissioning, start-up and shutdown to ensure that the generation of corrosion products is minimised. We are content with the development of these procedures at the current time, but we would check the final specifications before first operation at Sizewell C. We would keep these matters under review and have included them as part of the information/improvement condition IC 12 in the draft permit.

Argument 7 considers the selection of the secondary neutron sources. The neutron source is a component of the neutron flux measurement system. The source material NNB GenCo (SZC) selected as the secondary neutron source is antimony-beryllium. However, when beryllium is irradiated in a reactor it produces tritium; NNB GenCo (SZC) has calculated this would contribute 12% of the tritium aqueous discharge. The quantity of beryllium has been reduced by 50% for the UK EPR™ and there is a further commitment

as being ‘burned up’. The burnable absorbers negative reactivity decreases over time. Concentrations are managed so they are high when new high reactivity fuel is present and so that the absorption declines in line with the reduction in fuel reactivity.

from NNB GenCo (SZC) to assess the potential for removing the neutron source one year after the end of the 3rd fuel cycle (commitment 11, Head Document). This commitment aligns with GDA Assessment Finding UKEPR-AF03 and we would address the regulation of this matter through information/improvement condition IC 3 of the draft permit.

Argument 8 identifies the use of management arrangements and operational controls, specifically the arrangements in place to assess the impact of a new process or equipment that may produce radioactive waste and the application of BAT. The management arrangements are, in the first instance, to be intelligently adopted from those used by NNB GenCo (HPC). We would expect NNB GenCo (SZC) to use adequate arrangements and sufficient suitably qualified and experienced staff to implement its replication plan for these arrangements. Where these are not suitable, we would expect appropriate arrangements specific to Sizewell C to be developed and the learning shared with NNB GenCo (HPC).

In the application's Head Document, NNB GenCo (SZC) states that it applies the replication strategy to produce management arrangements, including procedures for design changes based on those developed at Hinkley Point C, where these are applicable to Sizewell C. Where they are not suitable, Sizewell C specific procedures would be produced. NNB GenCo (SZC) has developed a 'Procedures Adoption Plan' (PAP) to identify and carry out the required procedures.

We would continue to maintain an overview of the Procedures Adoption Plan's (PAP) content, suitability and implementation through our routine engagement activities with NNB GenCo (SZC). We would also satisfy ourselves that NNB GenCo (SZC) has adequate processes in place to assess, accept and implement the PAP. As in the permit for Hinkley Point C, we have included information/improvement condition (IC 1) in the draft permit, requiring an annual report on organisational development which includes management arrangements.

The arguments NNB GenCo (SZC) presented are consistent with the information provided in both the Hinkley Point C permit application and the UK EPR™ GDA. We have assessed the information and consider that the arguments and evidence presented to eliminate or reduce the generation of radioactive waste represent BAT. We have identified that we would require further evidence to support the Environment Case, which we would require by information/improvement conditions, specifically addressing:

- fuel specification
- implications of load following
- material selection
- primary and secondary coolant chemistry
- generation of corrosion products
- secondary neutron source use

We would monitor these arguments through our routine permit compliance activities during the design, construction, installation, commissioning and operational phases of the project to ensure that they continue to represent BAT.

5.3. BAT to minimise the quantity of radioactive wastes and selection of optimal disposal routes

NNB GenCo (SZC) has provided information in section 6.3. of the Environment Case through Claim 3, 'SZC Co. shall minimise the volume of radioactive waste disposed to other premises'.

Claim 3 is supported by information on 3 main arguments to support:

1. the selection of methods to minimise solid waste generation
2. application of volume reduction processes to solid wastes
3. selection of the optimal disposal routes for wastes transferred to other premises

A brief description of the evidence provided to support these claims is included below.

Argument 1 identifies methods through which the generation of solid waste from effluent discharge abatement can be minimised. NNB GenCo (SZC) has identified the sources of solid waste generation as being from operation and decommissioning activities and from the abatement of liquid and gaseous discharges (for example, from filters).

We expect the use of BAT to minimise the activity of liquid or gaseous waste discharged to the environment by using abatement techniques, and that volumes of solid radioactive waste for disposal are minimised. We would also expect the generation of waste from operation and decommissioning activities to be minimised. We have assessed NNB GenCo (SZC)'s approach against our Radioactive substances management: generic developed principles, specifically Radioactive Substances Management Developed Principles 3 – Use of BAT to minimise waste.

NNB GenCo (SZC) provided information identifying the types of solid radioactive waste that each type of abatement technique (for liquid and gaseous discharges) would produce; these have been summarised as follows:

For liquid discharges, abatement techniques would include the use of:

- single use cartridge filters that will be replaced when needed, based on differential pressure measurements or when a predetermined radioactivity level limit has been reached. This maximises filter life and minimises the volume of the filters that require disposal
- coarse pre-filters/strainers to maximise the life of finer filters. The larger pore size of coarse filters reduces the potential for blocking, while removing larger particulate which may damage the fine filters
- a selection of ion exchange resins to maximise the efficiency of removal of radioactive ions from the effluent
- an evaporator to concentrate effluent into a solid form, minimising radioactive discharges to the water environment and the volume of solid wastes for disposal

Minimisation of non-radioactive particles into radioactive effluent streams can create unnecessary radioactive waste or blind filters; we will expect the minimisation of non-radioactive particle to be included in NNB GenCo (SZC)'s BAT assessment for the operational management of the liquid waste processing system through an information/improvement condition (IC 11) in the draft permit.

For gaseous abatement, techniques identified to be used included:

- use of coarse pre-filters to protect finer HEPA filters to maximise filter life
- replacing HEPA filters when needed, based on differential pressure measurements, rather than at a defined frequency to maximise filter life
- use of inlet filters to minimise particulate taken into the building, and therefore discharged via filtration
- use of activated charcoal delay beds used to abate short-lived isotopes (noble gases and halogens) from gaseous effluents and are designed to last the 60-year life of the plant

We have assessed the information provided in the Sizewell C Environment Case on the abatement systems proposed for liquid and gaseous wastes; these are consistent with those identified in the Hinkley Point C permit application and the UK EPR^{TM} GDA. We are not aware of any site-specific reasons, new technological developments or management techniques or operational experience that would lead us to conclude that the techniques identified are not consistent with the use of BAT.

Argument 2 described the techniques that would be used to reduce the volume of waste once it has been produced, prior to its disposal. The Environment Case identified 3 reasons to do this:

- to make the most effective use of the existing waste management infrastructure
- to minimise the quantity of secondary wastes associated with waste management practices
- to reduce pressure on existing and future disposal facilities

The techniques identified in the Environment Case to do this are already widely used throughout the nuclear industry and are regarded as good practice. These include:

- **minimisation and segregation**: firstly, reducing materials or packaging that may become waste from entering radiologically controlled areas and becoming contaminated. Secondly, segregating waste types within the radiation controlled areas. This involves segregating clean waste from radioactive waste and then further segregating radiological wastes that will undergo different forms of treatment
- **characterisation** to identify appropriate disposal routes. NNB GenCo (SZC) has identified that it will use alternative disposal facilities, where appropriate, to reduce the volume of waste sent to the Low Level Waste Repository (LLWR) by good characterisation of the waste and applying clearance and exemption processes. This will reduce the additional waste volumes created by processing waste for disposal at LLWR and ensure LLWR capacity is effectively used
- **compaction:** low force compaction on site to reduce the volume of waste sent for disposal, or high force compaction carried out at specialist facilities prior to disposal

- **incineration**: incineration is used to reduce the organic constituent of the waste and achieves a high volume reduction. While the majority of the radioactivity is retained in the ash, there is an associated aerial discharge which will require abatement. Incineration takes place at off-site specialist facilities and reduces the overall waste volume sent for final disposal

Argument 3 justifies the selection of the optimal disposal routes for wastes transferred to other premises. To support this argument, NNB GenCo (SZC) described its strategy to dispose of waste from operations and decommissioning as soon as reasonably practicable. Where possible, alternative disposal routes to the LLWR would be selected. The Integrated Radioactive Waste Strategy (application document A2) has been assessed as part of our determination process.

During GDA, we concluded, as an Assessment Finding, that the proposed techniques for treating solid waste demonstrated BAT, subject to the future operator providing site-specific detail that will only be available when the detailed design is developed (UKEPR-AF12). We have assessed the information provided as part of this application and consider the proposed approach to radioactive waste management to represent BAT. However, we consider that further detailed information is needed on the design and operational management of the solid waste processing system. We have included this as requirement IC 17 in the draft permit.

5.4. BAT to minimise the discharges of gaseous and aqueous radioactive waste

We assessed this topic in GDA, see chapters 9 and 10 of our UK EPR decision document, and note that EDF has not identified any additional available techniques in its application to prevent or minimise discharges further at this time. We have confirmed that NNB GenCo (SZC) intends to use the same generic techniques presented in GDA and we have not identified any applicable techniques that could feasibly be applied since the UK EPR decision document and Hinkley Point C permit were issued. In the absence of any proposed changes, we rely on our conclusions in GDA. We produced Assessment Findings in GDA that future operators need to address. We have noted where NNB GenCo (SZC) has addressed these findings. Where detail is not finalised, we have carried them forward as further information/improvement requirements in the draft permit.

We have assessed the information NNB GenCo (SZC) provided in the Environment Case of the permit application. The information provided to demonstrate that BAT has been applied to minimise the discharges of gaseous and aqueous radioactive waste has been assessed with due regard to the relevant government policy and our RSR generic developed principles: regulatory assessment.

NNB GenCo (SZC) states in Claim 2 that it will minimise the amount of radioactivity discharged or disposed of to the environment. NNB GenCo (SZC) identified 7 arguments to support this claim. These are:

1. design, construction and operation of containment systems
2. operation controls and philosophies
3. sufficient capacity and resilience of treatment facilities for aqueous waste
4. management and abatement of aqueous wastes
5. management and abatement of gaseous wastes
6. abatement of tritium and carbon-14
7. decay storage of solid radioactive waste

We have provided a summary of each of NNB GenCo (SZC)'s arguments and our assessment of these as follows.

Argument 1 is supported by evidence that the design, construction and operation of containment systems would minimise the discharge of radioactive wastes by confining radioactive substances and preventing them from leaking or escaping to the environment, other than from permitted discharge points. The argument provides supporting evidence for 5 systems:

- primary containment of the reactor core and coolant
- liquid wastes, including the discharge storage tanks
- gaseous discharge systems, which considered the containment of ventilation systems and gaseous waste treatment systems
- solid waste (ILW) interim storage, including the ILW package and containment structure
- containment of spent fuel in the spent fuel storage pool and the interim storage facility

In the GDA, we noted that the spent fuel pool and the in-containment refuelling storage water tank (IRWST) are the main sources of tritium in gaseous disposals due to the evaporative losses from the pools; these gaseous disposals were subject to Assessment Finding UKEPR-AF07. To ensure that we are satisfied with NNB GenCo (SZC)'s specification for controlling the fuel pool temperature, ventilation and chemistry before operations commence, we have included this Issue as part of requirement IC 13 in the draft permit.

NNB GenCo (SZC) provided evidence regarding the application of relevant codes and standards to the design and construction of containment systems, prevention of leaks, systems and arrangements for monitoring and testing for leak tightness and the management of leaks. We assessed this topic at GDA and for the Hinkley Point C permit application, and we consider that the proposals to minimise leaks demonstrate BAT. Further information was requested during the Hinkley Point C assessment to ensure information to meet GDA Assessment Finding UKEPR-AF06 regarding tank capacity and leak tightness was provided. The Sizewell C permit application provides information on tank capacities. However, we require further demonstration that the leak tight construction techniques applied to the liquid effluent discharge tank systems represent BAT. We address this through information/improvement condition IC 21 in the draft permit.

Argument 2 is supported by evidence that plant operational controls and philosophies will be used to minimise radioactive discharges and waste. NNB GenCo (SZC) states that it will minimise the generation of radioactive waste through good operational control, for example, by controlling the generation of contamination at source and ensuring good containment is in place. Through these operational controls the generation of radioactive waste requiring disposal will be minimised. This is supported by evidence presented as part of 3 sub-arguments:

- control of coolant chemistry to ensure integrity of the secondary circuit, preventing the transfer of radioactivity from the primary coolant to the secondary circuit
- reactor start-up and shutdown philosophies to minimise corrosion, and therefore minimise the release of radioactivity into the primary coolant and discharge to the environment
- design to minimise waste production during operation and decommissioning, where upstream techniques are used to minimise the amount of contamination prior to it reaching the treatment plants

We assessed the proposals for minimising radioactive discharges and waste through the use of operational controls during GDA and in our assessment of the Hinkley Point C permit application and accepted the BAT arguments made. The proposals for Sizewell C are consistent with GDA and Hinkley Point C, and we have not identified any new technological or management techniques or operational experience that would change our assessment and therefore we consider them to be BAT.

Argument 3 states that ”the liquid waste processing system is designed to have sufficient capacity and resilience to effectively treat all anticipated aqueous radioactive wastes”. NNB GenCo (SZC) states that this is because the system is designed to:

- treat the volume of radioactive effluents that could be expected to arise
- ensure all of the treatment options are available to treat all of the effluents
- accommodate future operational flexibility
- the system and equipment is designed and specified to maximise its durability and enable maintenance and replacement of plant
- the system is designed with sufficient sampling and monitoring to enable appropriate management of radioactive waste

NNB GenCo (SZC) provided evidence to demonstrate the liquid waste processing system has sufficient capacity to treat liquid wastes during normal operations and to cope with unexpected events. The evidence provided was based on operational experience from existing EDF plants and showed that the time taken to process arisings from the process drains, chemical drains and floor drains was less than the time taken to accumulate arisings. In addition, the design allows the use of additional storage capacity by using the additional liquid waste discharge system storage tanks as buffer storage in the event the liquid waste processing system head tanks are unavailable.

Liquid waste is routed to the liquid waste system header tanks. From this point, the design has 3 potential treatment options: filtration, evaporation and demineralisation. The treatment selected is based on the characteristics of the liquid waste to be treated. The design assumes that floor drains will be treated by filtration, process drains by demineralisation, and chemical drains by evaporation. However, the design allows any of these waste streams to be treated by any of the treatment options and to be re-routed for additional treatment by more than one treatment option, if needed. We consider this approach to liquid waste management to represent BAT as it allows the use of different treatments suited to the waste stream and does not foreclose options.

Based on the information provided, we consider that the capacity of the system and the flexibility of the abatement options contributes towards BAT.

Argument 4 describes how management and abatement techniques are used to minimise aqueous discharges. The measures proposed in the application's Environment Case (A1) apply 3 main principles in the design, which are:

- use of containment to minimise the generation of radioactive wastes and their discharge to the environment
- use of abatement (such as filtration) to reduce the radioactivity discharged to the aqueous environment by transferring or retaining the radioactivity as a solid waste
- storage of radioactive wastes containing radionuclides with short half-lives, to allow radioactive decay prior to discharge

To implement these principles, NNB GenCo (SZC) has proposed to incorporate the following into the design:

- ion exchange for radioactive waste discharge abatement
- optimise selection of ion exchange resins to maximise effectiveness and minimise waste
- evaporation of liquid wastes to minimise discharges
- filtration of liquid discharges
- segregation and management of liquid effluents, to recycle and optimise treatment methods
- decay storage of liquid effluent prior to discharge
- control of the fuel pool water chemistry and temperature

We assessed these design features during GDA and during the Hinkley Point C permit application. The permit for Hinkley Point C includes the following information/improvement conditions:

- the operator shall provide the Environment Agency with a report on the detailed design proposals for the liquid waste processing system, including a BAT assessment
- the operator shall provide the Environment Agency with a BAT assessment to demonstrate the use of the evaporator, the choice of filter porosity and the demineralisation media have been optimised. The operator shall also provide evidence that the liquid waste processing system has sufficient capacity and

resilience (for example, in case of outage due to maintenance or breakdown) to cope with all the aqueous radioactive waste arisings

Consistent with these conditions, NNB GenCo (HPC) carried out further work to develop the design and associated BAT justifications of the liquid waste processing system for Hinkley Point C. NNB GenCo (SZC) has adopted this additional information and incorporated it into the Sizewell C Environment Case as part of this application. We therefore consider that the design and justification presented for Sizewell C contribute to BAT.

Argument 5 describes how management and abatement techniques are used to minimise gaseous discharges. NNB GenCo (SZC) identified the following evidence to support this argument:

- decay storage of gases prior to discharge; noble gases such as krypton and xenon that have a high activity level and short half-life, are abated using decay storage. Decay storage provides for a period of hold-up sufficient for short-lived radionuclides to decay before release as part of the eventual discharge: it is especially useful in reducing the release of activity in cases where there is no other viable treatment option, for example, for the chemically inert noble gases
- process gas recirculation system: reuse of the nitrogen purge gas retains the short-lived radionuclides and allows them to decay within the plant
- filtration of gaseous effluent: pre-filters and HEPA filters abate fission and activation products associated with particulates within the gaseous discharge system. Iodine filters are implemented during both normal operation and potential accident conditions in order to abate iodine if a pre-determined level of activity is exceeded

We assessed these topics during GDA and during the determination of the Hinkley Point C permit application and have considered NNB GenCo (SZC)'s arguments. We consider NNB GenCo (SZC)'s proposals for minimising radioactive gaseous discharges contribute to BAT.

Argument 6 discusses the use of abatement techniques for removing carbon-14 and tritium. These radionuclides were identified for additional consideration because their physical and chemical properties mean that they are difficult to remove from waste streams and they are not removed by the abatement systems proposed in the design of the gaseous discharge system. NNB GenCo (SZC) described the various options that were considered and has taken learning from other boiling water and pressurised water reactors. Following a review of the various potential methods, NNB GenCo (SZC) asserted that the technologies to abate these radionuclides were either not suitable or had not been developed sufficiently for use on operating reactors.

In both cases, NNB GenCo (SZC) has presented a BAT argument that the cost of development and implementation of technologies, combined with the generation of large volumes of secondary wastes (capture media) would be grossly disproportionate to the benefits gained. Therefore, NNB GenCo (SZC) has focused on minimisation and partitioning techniques as described in section 5.6.1 and 5.6.2. We agree with NNB GenCo (SZC)'s assessment (see section 5.6).

Argument 7 details the application of minimisation by the decay storage of solid radioactive waste. NNB GenCo (SZC) identifies the use of decay storage specifically in the case of the long-term storage of ILW, which will be stored between 40 and 100 years. This allows significant decay of radionuclides cobalt-60 (half-life of 5.27 years), caesium-137 (half-life of 30.2 years) and iron-55 (half-life of 2.7 years) and reduces the category of the waste from ILW to LLW (for example, for dry active waste and spent water filters). Where waste is identified as 'dry active waste', this allows further treatment of the waste once the radioactivity has reduced; wet wastes are immobilised to ensure passive safety during the period of decay.

We have assessed the information provided and consider that the techniques NNB GenCo (SZC) has proposed to minimise the discharges of gaseous and aqueous radioactive waste contribute to BAT for the installation. We have included information/improvement conditions IC 2, 5, 6, 7, 11, 13, 17 and 21 in the draft permit to cover issues such as specifications and final equipment selection that need to be completed prior to operations commencing.

5.5. BAT to minimise the impact of discharges

We have assessed the BAT arguments and evidence NNB GenCo (SZC) presented to minimise the generation of radioactivity and therefore the generation of radioactive waste and discharges to the environment. Where wastes are generated, we would require NNB GenCo (SZC) to apply BAT to minimise the impact of those discharges on the environment and members of the public to be as low as reasonably achievable (ALARA), taking social and economic factors into account.

NNB GenCo (SZC) provided BAT arguments in section 6.4 of the Environment Case through claim 4, which states: "SZC Co. shall minimise the impacts on the environment and members of the public from radioactive waste that is discharged or disposed of to the environment". Four arguments were presented to support this claim:

1. preferential partitioning of radionuclides to optimise waste form and minimise the impact on the environment from the discharge or disposal
2. the liquid effluent discharge system will be designed to minimise the impacts of radioactive discharges to the environment
3. use of appropriately designed gaseous discharge points will minimise impacts on radioactive discharges to the environment
4. doses from storage of spent fuel and ILW will be minimised

We considered that the 4 arguments identified were adequate to cover the proposed disposals and discharges. NNB GenCo (SZC) provided additional detailed evidence to support these arguments which we have assessed. We have provided a summary of each argument as follows:

Argument 1 describes how radioactive substances are partitioned into the optimum form (that is the form with the lowest environmental impact when it is disposed of) – liquid, gaseous or solid wastes – to minimise the radiological impacts from the discharge or disposal to the environment.

If it is not practicable to contain all the radioactivity generated in solid material, then the discharge route with the lowest radiological impact should be selected. The best option will depend on a range of factors, including which radionuclide is considered.

The arguments presented identify how 3 of the most significant radionuclides are partitioned across solid, liquid and gaseous wastes, therefore reducing the overall impact on the environment and public. These are:

- the preferential partitioning of tritium into liquid effluents. The dose per unit discharge is higher for gaseous discharges of tritium than liquid discharges, it is therefore preferable that discharges are in liquid form
- the preferential partitioning of iodine isotopes into liquid effluents. Iodine isotopes are retained in the liquid form where they are treated by abatement and the recycling of liquid effluent which enables the decay of short-lived isotopes of iodine
- the preferential partitioning of carbon-14 into gaseous discharges. NNB GenCo (SZC) has stated that 80 to 95% of carbon-14 is discharged in the gaseous form, with 5 to 20% being discharged in the aqueous form or held within a solid waste. Increased recycling of the coolant increases the quantity of carbon-14 in the gaseous form. Carbon-14 is produced in the primary circuit, and we have accepted that BAT is used to minimise production and that there are no available techniques to abate carbon-14 at the levels of production expected

Preferential partitioning for the radionuclides was assessed during the GDA and during the Hinkley Point C permit determination. During these assessments, NNB GenCo (HPC) said that, of the remaining carbon-14 not discharged into gaseous discharges, some is retained in filters, ion exchange resins and evaporator concentrates and becomes solid waste, while the remainder becomes aqueous waste. The precise partitioning between solid and liquid waste is variable and subject to some uncertainty.

The Integrated Radioactive Waste Strategy (document A2) included in the application states that 80% of the carbon-14 discharged is in the form of methane and 20% is in the form of carbon dioxide. The mass of this material at the proposed limit is very small, equivalent to 6.8 and 1.7 grams per year respectively. During its modelling and assessment of the radiological impact of the proposed discharges, NNB GenCo (SZC) assumed that 100% of the carbon-14 is discharged as $^{14}CO_2$ which gives a more conservative assessment (overestimate) of the dose to the representative person. The estimated impact of discharges at the limit using this assumption is considered in the dose assessment section of this document (see chapter 7).

We identified Assessment Finding UK EPR-AF09 during GDA on the matter of the partitioning of carbon-14 in waste and this was included as an information/improvement condition (IC 15) in the Hinkley Point C permit. Hinkley Point C is not yet in operation and so further evidence is still required around how the radioactive waste management regime will affect the disposal of carbon-14 at Sizewell C. We have included this as an improvement/ improvement condition IC 15 in the draft permit.

Argument 2 is based on the use of an appropriately designed liquid effluent discharge system that would minimise the impacts on radioactive discharges to the environment. NNB GenCo (SZC) described the 3 discharge system as consisting of:

- system 1: The liquid radwaste monitoring and discharge system. This system collects treated radioactive liquids, and after monitoring discharges them via the outfall pipeline
- system 2: The site liquid waste discharge system collects effluent that normally contains no chemical or radiological contaminated (although there is a potential for a minor radiological discharge via this route from the turbine hall)
- system 3: The additional liquid waste discharge system can be used to provide additional capacity for both systems 1 and 2 if needed. The system allows liquid to be stored and re-routed for additional treatment options if needed. This system discharges via the same route as systems 1 and 2

The size and design of discharge tanks are important considerations when determining what constitutes BAT. The size should be adequate to cope with predictable effluent volumes. The design should be capable of containing the effluent over the life of the plant without any leaks. We raised GDA Assessment Finding UKEPR–AF06 on this matter in our GDA decision document for the UK EPR™. NNB GenCo (SZC) has provided information on the sizing and design of effluent tanks which demonstrates that the liquid waste processing system has sufficient capacity and resilience; see sections 6.2.11 and 6.2.18 of A1 Environment Case. Any further changes to the design will be subject to the design control processes set out in the application and are addressed through condition IC 2 in the draft permit.

Proposals for the operational management of the liquid waste processing system are not presented in the application. We have included condition IC 11 in the draft permit to address this. The discharge system performs 2 important functions to minimise the impact of the effluent: firstly, it allows sampling and checking of the effluent prior to discharge to ensure it meets all the appropriate criteria. Secondly, it dilutes and disperses the discharge.

A substantial dilution factor (of approximately 1,400) is achieved by mixing the radioactive effluent into the returning cooling water discharge, which is then discharged via the outfall pond and outfall tunnel into the North Sea. The discharge outfall would be located approximately 3.5km from shore to ensure good dispersion and help prevent re-entrainment. NNB GenCo (SZC) states that the location and design of the discharge outfall has been optimised on the basis of marine dispersion modelling. Our assessment (chapter 7) of radiological impacts determined that the group most exposed to aqueous discharges from Sizewell C are adult fishermen who would receive a dose of 3.7μSv/y, which is less than 1% of the public dose limit.

Argument 3 states that use of appropriately designed gaseous discharge points will minimise impacts on radioactive discharges to the environment. The 2 main discharge points for gaseous discharges are from Unit 1 and Unit 2 stacks. NNB GenCo (SZC) states that to minimise the impact of the gaseous discharges on the environment and people, the BAT option is to ensure good dispersion of the discharge; this is achieved by optimising the release height to minimise radiation doses to people and the environment.

The Sizewell C reference design is based on the Hinkley Point C design, which has a 70m stack for each reactor. To ensure this stack height continued to represent BAT at Sizewell C, NNB GenCo (SZC) carried out an assessment for routine discharges that considered:

- the impact of dispersion and ground concentration close to the Sizewell C site
- the radiological impact for the representative members of the public from releases at Sizewell C
- the safety risk of constructing and maintaining a higher stack
- cost of construction
- landscape and visual impact of an increased stack height in the Sizewell C area

NNB GenCo (SZC) stated that the outcome of the assessment was that the stack heights would be set at 70m, as an increase in height would not significantly reduce the impact of discharges but would increase cost and the visual impact.

Our assessment of radiological impacts (chapter 7) determined that the group most exposed to discharges to atmosphere from Sizewell C (adults spending significant amounts of time at the shoreline/beach location) would receive a dose of 1.4μSv/y, which is less than 1% of the public dose limit.

We therefore consider that stack heights of 70m for each unit provides adequate dispersion and is the BAT option for the installation at Sizewell C.

Argument 4 states that doses from storage of spent fuel and ILW will be minimised. The evidence provided in the Environment Case considers the exposure from both the direct[6] radiation from the interim storage facilities and beta and gamma exposure from discharges to atmosphere from those facilities.

The Environment Case states there are 2 potential routes of discharge to atmosphere from the storage of ILW and spent fuel:

- gaseous tritium escaping the fuel cladding; this should be mitigated by the leak tight cask it is contained in (the life expectancy of a cask is 120 years). Any tritium that does escape is expected to be in small quantities

[6] Direct radiation is where a member of the public is exposed to radiation directly from a source of radiation on the site, whereas exposure from discharges is the result of radioactive contamination entering the environment and food chain.

- the evolution of tritiated gas from ILW packages that may then diffuse through the package; again, the expectation is that this discharge would be small

Direct radiation from the interim storage facilities for spent fuel and the ILW storage building will potentially result in members of public receiving some low level exposures. NNB GenCo (SZC) has stated that the design of the ILW packages and spent fuel dry storage casks will be designed to reduce doses as far as reasonably practicable. The detailed design of these facilities is underway at Hinkley Point C, with the intention of replicating the design at Sizewell C.

We have reviewed the assessment NNB GenCo (SZC) completed and verified and validated its assessment of dose from the ILW and spent fuel stores. We will assess further design development of the ILW interim storage and interim spent fuel store and the supporting BAT assessments. A requirement to provide this information is included in condition IC 2 in the draft permit.

5.6. BAT to minimise and mitigate discharges of specific radionuclides

We have summarised in sections 5.6.1 to 5.6.5 the techniques used to minimise and mitigate arisings of radioactive waste to be disposed of under the permit.

5.6.1. Tritium

NNB GenCo (SZC) described measures to reduce the production of tritium and the release of tritium into radioactive waste for disposal in the Environment Case (Support Document A1) of its submission. In summary, these are:

Tritium minimisation

- enrichment of boron to increase levels of boron-10 in the injected boric acid
- depletion of lithium-6 in the injected lithium
- optimal pH control by boron-lithium coordination
- use of gadolinium oxide as a burnable poison
- optimisation of the gadolinium load
- use of control rods without boron
- use of secondary neutron sources with lower mass of beryllium
- high standards of fuel design and fabrication
- improved management of coolant storage and treatment system based on the N4 pressurised water reactor (PWR) design utilised in France
- it is expected, but yet to be quantified, that the use of a hydrogen recombiner and dryers (for safety purposes) may have a consequential benefit of partitioning tritium into the liquid waste stream
- retention of tritium arisings in the liquid stream is optimised via appropriate control of the temperature of the In-containment refuelling water storage tank (IRWST) and other pools in the reactor building and fuel building

Tritium mitigation techniques

In the environment case NNB GenCo (SZC) concluded that although techniques exist to reduce tritium in discharges, the benefits in terms of reduced public exposure are small compared to the potential cost and resources of implementing them. We accept that the costs and other resources required would be grossly disproportionate to the very small marginal benefit to be gained.

It is widely accepted at present that the industrial scale abatement of tritium in the liquid effluent of nuclear power stations and nuclear reprocessing facilities is currently not technically feasible, for example, Overview of national statements on the implementation of PARCOM Recommendation 91/4 (OSPAR 2016). However, we continue to keep this under review.

5.6.2. Carbon-14

NNB GenCo (SZC) identified the following techniques for minimisation and mitigation of carbon-14 production:

Carbon-14 minimisation

- management of nitrogen concentration in primary coolant
- improvement of core design (compared to existing PWRs)
- there are no available techniques to minimise the production of carbon-14 from oxygen-17 (oxygen-17 is a stable isotope of oxygen found in the reactor coolant water that is converted to carbon-14 by the neutrons in the reactor core)

Carbon-14 mitigation

In the Environment Case, NNB GenCo (SZC) assessed potential abatement for carbon-14 discharges and concluded that they were not BAT based on technical maturity, costs and international operational experience. We accept that for the mass, and activity of carbon-14 expected from the planned operations of the UK EPR at Sizewell C there are currently no practicable mitigation techniques.

5.6.3. Beta emitting radionuclides associated with particulate matter (including caesium and cobalt)

NNB GenCo (SZC) identified the following techniques for minimising and mitigating cobalt-58, cobalt-60 and caesium-137 production:

Cobalt-58 and cobalt-60 minimisation

- use of cobalt-free material as an alternative to Stellite™
- minimisation of cobalt-content of materials where required
- use of 690 alloy for steam generator tubes
- hot functional tests during plant commissioning
- optimisation of the primary circuit chemistry
- use of helicoflex seals and avoidance of antimony in bearings

- use of zinc injection

Cobalt-58 and cobalt-60 mitigation

- filtration
- demineralisation (ion exchange resins)
- evaporation

Caesium-137 minimisation

- use of quality assured fuel manufacturing arrangements to minimise the quantities of residual traces of uranium present at the surface of the fuel
- high standards of fuel design and fabrication to minimise fuel cladding defects and residual traces of uranium on the surface of the fuel

Caesium-137 mitigation

- filtration
- demineralisation (ion exchange resins)
- recirculation of effluents in the demineralisers of the liquid waste processing system

5.6.4. Noble gases

NNB GenCo (SZC) identified the following techniques for minimising and mitigating noble gas production:

Noble gas minimisation

- high standards of fuel design and fabrication to minimise fuel cladding defects and residual traces of uranium on the surface of the fuel
- improvement of fuel performance
- reactor operation to minimise the risk of fuel failure and control the concentration of fission products in the primary coolant
- identification and removal of leaking fuel pins during refuelling

Noble gas mitigation

- noble gases are transferred to the gaseous stream by the coolant storage and treatment system degasser
- charcoal delay beds hold-up discharges and allow decay to occur
- recycling of the purge gas in the gaseous waste processing system

5.6.5. Conclusions on BAT to minimise and mitigate discharges of specific radionuclides

We assessed this topic in GDA in chapters 7, 8 and 9 of our UK EPR decision document. We concluded that the techniques proposed for minimising the generation of radioactive waste and radioactive discharges represented BAT and we asked for more information in the detailed design on the minimisation of discharges in assessment findings UK EPR-

AF04, UK EPR-AF07, UK EPR-AF08 and UK EPR-AF09. We also assessed this topic during the permit application process for Hinkley Point C and we included information conditions in the permit corresponding to the GDA Assessment Findings.

We have assessed the BAT arguments and evidence NNB GenCo (SZC) presented to minimise the generation of radioactivity and therefore the generation of radioactive waste and discharges to the environment. When assessing the application for Sizewell C, we considered several factors:

- the difference the Sizewell C location could make compared to the GDA and Hinkley Point C. In this case, we concluded that the methods used to minimise the production of radioactive waste and the abatement techniques are not affected by the location
- the availability of new technology and operational experience: we have assessed the evidence NNB GenCo (SZC) provided for tritium and carbon-14 discharges. We have taken into account IAEA Technical Support Series No. 421 and concluded that abatement for tritium and carbon-14 is not currently technically and economically feasible and that reduction of source term alone is considered BAT. We will continue to review this. However, our focus will remain on minimising the generation of these radionuclides
- changes to legislation or policy: our regulations have not changed in this area; the operator is still required to demonstrate that they have applied BAT

We have therefore concluded that the minimisation and abatement techniques that NNB GenCo (SZC) have identified for Sizewell C represent BAT.

5.7. Management and disposability of radioactive waste for which there is currently no disposal route available

NNB GenCo (SZC)'s Environment Case provides information on radioactive wastes where there is currently no disposal route. These wastes include intermediate level waste (ILW) and spent fuel. The strategy proposed in the Environment Case and the Integrated Radioactive Waste Strategy (A2) for these wastes is to store them on site until a disposal route becomes available for ultimate disposal in accordance with the government's National Policy Statement. While wastes are stored on site they will be kept in safe, secure storage and regulated by the Office for Nuclear Regulation.

EDF and AREVA provided information on these wastes in the GDA Pre-Construction Environmental Report (PCER) for the UK EPR™, which we assessed during GDA. We found this information to meet our regulatory expectations, subject to 2 GDA Assessment Findings on spent fuel storage:

- GDA Assessment Finding UKEPR-AF16 required a future operator to propose techniques for the interim storage of spent fuel following a period of initial cooling in the pool and justify that the proposed techniques demonstrated BAT
- GDA Assessment Finding UKEPR-AF17 concerned ensuring proper management and future disposability of spent fuel

During GDA and during the Hinkley Point C permit assessment, NNB GenCo (HPC) had initially selected interim wet storage for the spent fuel following the cooling period in the spent fuel pool; the selection of this option is planned to change to interim storage in a dry store at Hinkley Point C. We assessed the change and agreed that the new option also represented BAT, and it is this latter option that is being replicated at Sizewell C. We regard both wet and dry storage as BAT as they meet our requirements. These are that the applicant must demonstrate, for any waste created for which there is no currently available disposal route:

- its suitability for eventual disposal
- how it would be managed in the interim, so as not to adversely affect its suitability for its ultimate disposal

NNB GenCo (SZC) has provided information within section 6.1.1 of the Environment Case which identifies dry storage of ILW and spent fuel, prior to disposal at the geological disposal facility (GDF) as the BAT option.

We are satisfied that the replication of the dry store option for spent fuel at Sizewell C represents BAT and the information provided meets the requirements of GDA assessment finding UKEPR-AF16.

To address GDA Assessment Finding UKEPR-AF17, further information has been provided in the Environment Case, which states: ”since GDA, Radioactive Waste Management Ltd (RWM Ltd, a subsidiary of the Nuclear Decommissioning Authority (NDA)), has provided further confidence that operational ILW anticipated to be generated by the Hinkley Point C and Sizewell C power stations will be disposable by issuing a conceptual Letter of Compliance (LoC). The SZC project will engage with Nuclear Waste Services Ltd (a new division of the NDA formed in January 2022 and the successor organisation to LLWR Ltd and RWM Ltd) to ensure a level of confidence appropriate to the project phase is achieved for the disposability of anticipated waste and spent fuel.”

We will work with ONR to ensure that an adequate Radioactive Waste Management Case supported by Letters of Compliance from the future higher activity waste repository operator (Nuclear Waste Services Ltd) is developed for spent fuel from Sizewell C and that the level of confidence in disposal remains appropriate for the project phase.

We are satisfied that NNB GenCo (SZC) has demonstrated the suitability for disposal of any wastes for which there is no current available disposal route (ILW and spent fuel). NNB GenCo (SZC) has also demonstrated that the wastes will be managed, in the interim, in a manner which will not prejudice their ultimate disposal. NNB GenCo (SZC)’s proposals are consistent with government policy that higher activity wastes will be managed in the long term through geological disposal, with safe and secure interim storage.

5.8. Conclusion

We consider that NNB GenCo (SZC)’s proposals, subject to the improvement and information requirements previously identified, demonstrate the use of BAT and the optimisation of the management of radioactive waste, and have due regard to currently relevant statutory requirements, our guidance, government guidance and policy.

6. Our assessment – part 3: Limits and notification levels

The permit specifies the types of, and routes by which, radioactive waste may be disposed. These are set out in the following sections.

In the draft permit, we have set limits on disposals in accordance with the statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment, (UK Parliament, 2009a). That is, we have set limits based on the use of BAT by operators to minimise disposals to the environment and therefore to minimise the impacts of those disposals. We have set our limits with allowance for ‘normal operation’ of the facility. ‘Normal operation’ takes account of operational fluctuations, trends and events that are expected to occur over the lifetime of the facility. More detail on how we set limits is given in our document ‘Criteria for setting limits on the discharge of radioactive waste from nuclear sites’ (Environment Agency, 2012c), known as the ‘limit setting guidance’.

NNB GenCo (SZC) described in chapter 4 of the application’s Head Document how the nuclides to be limited are produced in the UK EPR™. Its explanation was based on information EDF and AREVA provided in the Pre-Construction Environment Report (PCER) that we assessed during the GDA.

NNB GenCo (SZC) described measures to minimise production and mitigate releases of radionuclides in its Environment Case (Support Document A1, section 5.1). We have discussed these measures in chapter 5 of this document.

The limits we have set in the draft permit are based on the best technical information available from the Generic Design Assessment (GDA), as used in the permitting of the sister station Hinkley Point C, and in the application by NNB GenCo (SZC). We have set limits for these radionuclides on the basis of a rolling 12-month period. We would keep these limits and notification levels under review in light of operational and regulatory experience.

We may also choose to specify quarterly notification levels and weekly action levels where we believe these are appropriate. We have described where we have used these controls in the draft permit in sections 6.3 and 6.4.

The next sections discuss what we mean by normal operation, discharge limits, quarterly notification levels and weekly advisory levels. These are followed by sections on gaseous radioactive wastes and liquid radioactive wastes, which provide a brief summary of the discharge systems by which gaseous and liquid radioactive wastes are disposed. Finally, we discuss the radionuclides that we propose to limit.

6.1. Normal operation

NNB GenCo (SZC) has applied for a permit to allow 'normal operation' of 2 EPR™ reactors at Sizewell C. We clarified NNB GenCo (SZC)'s understanding of 'normal operation' with regard to the impacts of the Grid Code requirements to be able to respond to frequency deviations, load-follow or de-rate to maintain grid stability. Nuclear power stations in the UK have rarely been asked to carry out all of these operations. We sought reassurance that the assumptions made underpinning the application and that the impacts of any foreseeable grid requirements would not challenge the BAT case, waste arisings or impacts reported in the application. NNB GenCo (SZC) stated that it has assumed Sizewell C will not be operated in a load following mode[7]. However, it may be a potential requirement under the Grid Code[8], which is not yet in place. It also stated that the design philosophy of the EPR™ is to allow for load following, and this has been accounted for in setting discharge limits. Should it be necessary for Sizewell C to load follow in the future, a BAT assessment will be produced as necessary.

We have placed a requirement in the draft permit for NNB GenCo (SZC) to provide further information on the potential impact of the Grid Code requirement if load following is included in terms of radioactive waste disposals, and how these will be mitigated using BAT. This requirement is condition IC 22 in the draft permit.

6.2. Discharge limits

We have considered our Radioactive Substances Management Developed Principles 12 (RSMDP12) on limits, levels and discharges, and our limit setting guidance to decide which radionuclides or groups of radionuclides to set limits for and the appropriate values for those limits.

We set discharge limits to:

- ensure that the radiation exposure of members of the public is less than the statutory dose limits and constraints and is as low as reasonably achievable
- ensure the environment is protected
- provide a reference for the indication of operational discharge performance and the application of the BAT to minimise discharges

We must be satisfied that operators can comply with the limits we set without unduly affecting their ability to operate. Therefore, we must set limits which provide sufficient

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[7] A power plant that load follows is one that adjusts its power output as demand for electricity fluctuates.

[8] Grid Code is the specification that a power plant must meet to ensure a safe and secure connection to the public electric grid. In the UK, the Grid Code is owned and administered by National Grid under the terms of its transmission licence.

headroom for normal operation, provided that the operator applies BAT to minimise the activity of radioactive waste discharged and complies with statutory dose limits and constraints.

We have considered the radionuclides and groupings to be discharged, in particular those contained in our RSR Pollution Inventory reporting form, and their quantity and significance in dose terms, against our guidance. The criteria we have considered are further explained in chapter 3 of our limit setting guidance (Environment Agency, 2012c). Table 6.1 shows the radionuclides which we consider it appropriate to set limits and levels for along with our criteria for doing so.

Table 6.1 Radionuclides selected for limits

Criterion for significance	Gaseous	Aqueous
The dose to the most exposed group exceeds one μSv/y	Carbon-14	Carbon-14
The 500-year collective dose to the world population exceeds one person Sv	Carbon-14	Carbon-14
Disposal exceeds one TBq /y	Tritium Carbon-14 Noble gases	Tritium
Impact on reference organisms exceeds 40μGy h^{-1}	None	None
Indicators of performance and process control	Tritium Noble gases[*1] Iodine-131 Beta emitting radionuclide associated with particulate matter[*2]	Cobalt-60 Caesium-137 Other radionuclides

[*1] Noble gases include argon-41, krypton-85, krypton-85m, krypton-87, krypton-88, krypton-89, xenon-131m, xenon-133, xenon-133m, xenon-137 and xenon-138.

[*2] Beta emitting nuclides associated with particulate matter include chromium-41, manganese-54, iron-59, cobalt-58, cobalt-60, caesium-134, and caesium-137.

The representative person is an individual receiving a dose that is representative of those members of the public who are estimated to receive the highest dose overall. Where doses are separately assessed for different types of discharges, the term ‘group most exposed to’ is used. The dose to the representative person may be less than the total of all the doses to the ‘groups most exposed’ as the representative person may not be fully exposed to all discharges and or routes for disposal.

In this chapter, we consider discharges to atmosphere and liquid discharges separately, therefore we have reported the dose to the group most exposed to atmospheric and marine discharges respectively. The representative person and the group most exposed to liquid discharges in our assessment is an adult sea fish consumer, the group most exposed to atmospheric discharges is an adult living in close proximity to the site. Collective dose is the sum of all individual doses to a group of people over a given time period. We consider collective dose to the UK, EU and world populations over 500 years in our radiological impact assessment. In this chapter, we have considered the collective dose to the world population truncated to 500 years to guide our determination of limits. Note that inclusion of a type of radionuclide in one media does not imply it will automatically be included in other media. For example, against our criteria, iodine radionuclides are not significant in aqueous discharges, but are limited in gaseous releases.

We have set limits based on a rolling 12-month period.

6.3. Quarterly notification levels

In the draft permit, we have also set quarterly notification levels (QNLs) on the radionuclides that are subject to limits. Quarterly notification levels in the permit require the operator to notify us if the levels are exceeded. They help us to monitor and ensure that BAT is being used to minimise discharges and their impacts. Quarterly notification levels are based on the expected best performance of the plant and are intended to highlight unusual discharge trends or events that may indicate that BAT is not being used to minimise discharges.

Exceeding a QNL is not a non-compliance with the permit, but it would be if an operator failed to let us know that they had exceeded a QNL or failed to provide a report that reviews the circumstances and whether they have continued to apply BAT.

6.4. Weekly advisory levels

If a significant proportion of the permitted discharges is released in a short time period, this could lead to higher annual doses than those assessed assuming a uniform release rate. We therefore sometimes set limits or advisory levels in relation to such short-term discharges.

Short-term discharges to atmosphere may occur during the normal operation of Sizewell C. Such discharges may occur during reactor start-up or shutdown and lead to larger than average releases over relatively short periods of time.

There is no requirement to model the impact of short-term liquid discharges to the marine environment as significant short-term liquid discharges are unlikely to occur. Liquid discharges from Sizewell C would be held in storage tanks before release and follow a semi-continuous release process. There are also considerable dilution effects in the marine environment caused by currents and tides.

We have considered whether we need to include any conditions or limits in the draft permit as a result of these short-term effects. In particular, we have considered whether we should include weekly advisory levels (WALs). We use WALs where there is the potential for short-term releases to result in close to or exceed the source constraint of 300μSv. If WALs are exceeded, operators are required to inform us and the Food Standards Agency (FSA) and to assess the impact of any radioactivity deposited onto pasture and crops near the site. This would enable both us and the FSA to consider if we need to take any further action to protect the public.

We accept NNB GenCo (SZC)'s assumption that short-term releases to atmosphere are unlikely to occur from both reactors at the same time. Our assessments, carried out in accordance with the National Dose Assessments Working Group (NDAWG) Guidance, for a short-term release to atmosphere from a single reactor at Sizewell indicate that even if the entire annual limit was to be discharged in a short period of 12 hours, the doses would still remain less than the source constraint (300μSv) and radionuclide concentrations in foodstuffs would remain below the maximum permitted levels (MPL)[9] in food. For this reason, we have decided it is not appropriate to set any WALs.

6.5. Systems for discharge of gaseous radioactive waste to the environment

The main sources of gaseous radioactive waste for the UK-EPR^{TM} are:

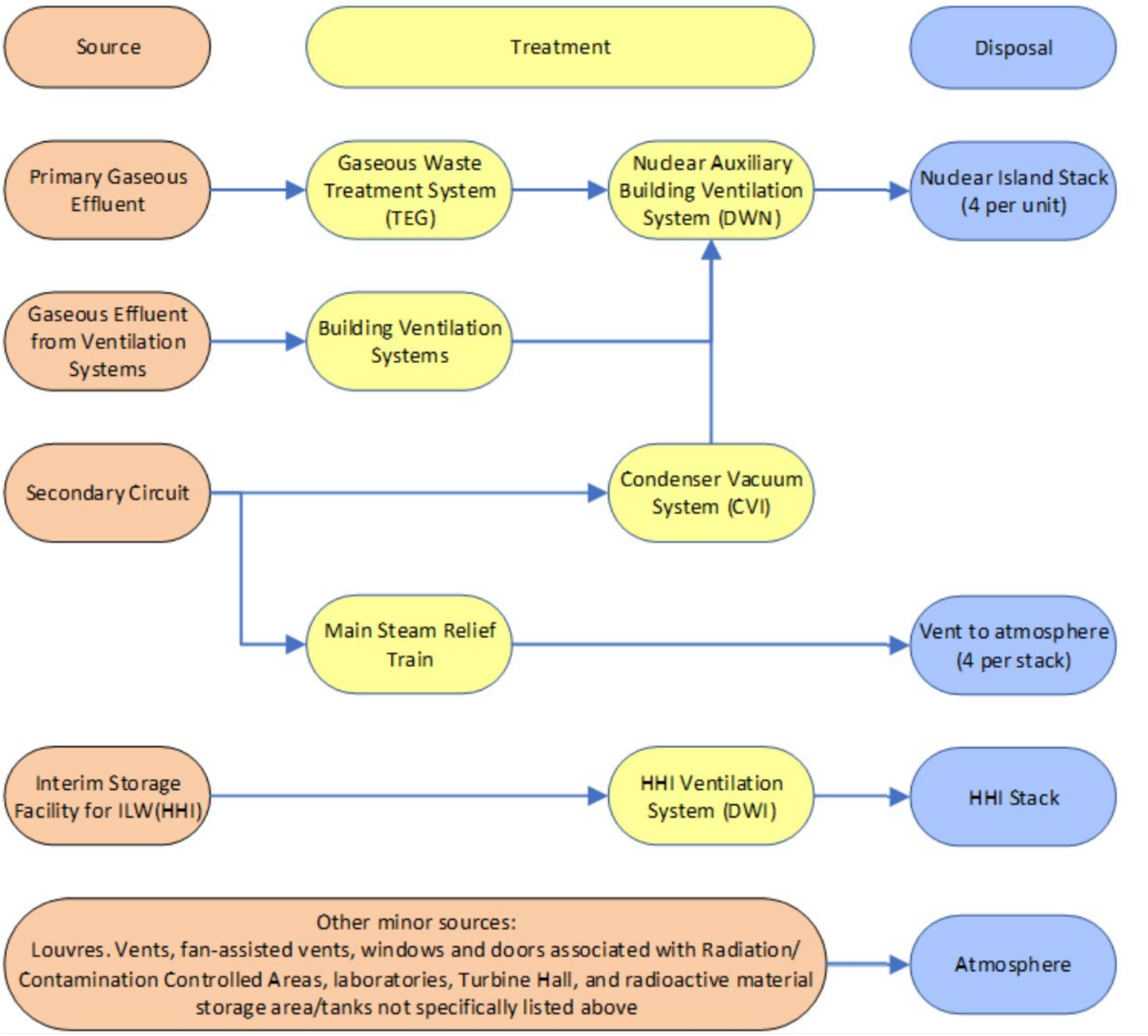
- **degassing of the primary coolant** – in the primary circuit effluent degassers in the coolant storage and treatment system or from head spaces in the tanks and vessels containing primary circuit effluent. The radioactive species are primarily, hydrogen, nitrogen, and gaseous fission and activation products. Hydrogen levels are controlled by purging the tank headspace with nitrogen sweeping. The gaseous waste treatment system collects waste and discharges via a carbon bed delay

9 Maximum permitted levels (MPLs) are defined in Euratom Regulation 2016/52 and are retained EU law. These specify limits for the amounts of radioactivity that are permitted in foods and animal feeds following a radiological emergency. This only applies following a nuclear accident or other radiological emergency. However, wider policy considerations mean that it is not appropriate to permit routine discharges that may result in these levels being exceeded.

system for decay of noble gases, HEPA filtration and the main unit vent discharge stack
- **degassing of the secondary circuit** – gas collected from the condenser vacuum system is sent via the nuclear auxiliary building, high efficiency particulate air (HEPA) filtered and discharged into the main stack. This route is provided to account for radioactive gas that might arise in the secondary circuit in the event of leakage from the primary circuit, for example, at the boiler tube interface
- **general ventilation of buildings with the potential for contamination** – ventilation air from the nuclear auxiliary building, fuel building, safeguard buildings, the reactor building, the access building, and the effluent treatment building is passed through HEPA filters, and iodine filters when necessary, before discharge

In Figure 7-10 of Support Document A2, NNB GenCo (SZC) provides a representation of 'SZC Radioactive Gaseous Effluent Routes'. We have reproduced this here for ease of reference.

Figure 6.1 Sizewell C radioactive gaseous effluent routes



These gaseous wastes would be collected together for discharge by the main stack of each unit at Sizewell C (Major outlets A1 and A2 in Schedule 3 of our permit). Each stack has representative sampling and monitoring (see the application Support Document C1 on plant monitoring) and discharges are made at a height of 70m. We concluded that the discharge height contributes to BAT (Claim 4, Argument 22), see section 5.5.

When NNB GenCo applied for the permit for Sizewell C's sister station Hinkley Point C we permitted wet fuel storage system ventilation requirements in the interim fuel store. This was regarded as a major outlet route. Since then, the design at Hinkley Point C, and consequently Sizewell C, has evolved. The spent fuel at NNB GenCo (SZC) Ltd would be stored in dry fuel canisters, resulting in reduced discharges of tritium. We have reflected this development and the low level of discharge expected from the facility, with the discharges being recognised as being via a minor outlet (A6).

The potential for the generation of particulate waste in routine fuel store operations is very low and we accept that NNB GenCo (SZC) does not intend to include systems for the mitigation of gaseous wastes from the interim spent fuel store.

Minor gaseous discharge routes are listed here. These make a minor contribution to the overall site gaseous discharges. We are proposing to limit the discharges from all minor outlets to 5% of the relevant site annual limit.

- outlet A3 – stack for the ventilation system of the interim storage facility for ILW. ILW will be securely packaged before storage. NNB GenCo (SZC) does not expect a filtered ventilation system will be needed in normal operation
- outlets A4 and A5 – main steam relief train vents, one for each unit. In certain circumstances, steam can be let down from the secondary circuit to the atmosphere through silencers and stacks. NNB GenCo (SZC) lists these as minor discharge points and says that due to radioactivity concentrations in the secondary circuit being so low under routine conditions, it is unlikely any appreciable radioactivity would be discharged through them
- outlet A6 – we have used this outlet reference to cover all other minor discharges to the atmosphere such as louvres, vents, fan-assisted vents, windows and doors associated with radiation/contamination controlled areas, laboratories, turbine hall and radioactive storage areas/tanks not specifically included in any other outlet

6.6. Gaseous radionuclide discharge limits

On the basis of replication of the nuclear island, NNB GenCo (SZC) has applied for the same radioactive discharge limits as we granted for Hinkley Point C. Each radionuclide to be limited is discussed here.

6.6.1. Tritium

The main source of tritium in gaseous discharges is from evaporation from the surface of pools in the plant, in particular the in-containment refuelling water storage tank (IRWST). We note that the nitrogen sweeping and gas recycling system and recombiner will result in some tritium being routed to the aqueous route.

The tritium is collected by ventilation systems and discharged through the main stacks. Some water vapour is condensed on cooling coils in the ventilation systems and then discharged via aqueous routes.

We accept that the measures proposed to minimise transfer of tritium from liquids to gaseous route contribute to BAT.

NNB GenCo (SZC) said that the ‘expected best performance’ is expected to result in gaseous releases of tritium of one TBq per year and proposes a limit of 6TBq per year. Allowing for the 2 units at Sizewell C, these are the same values presented in GDA, and at Hinkley Point C.

For tritium, we have set a limit in the draft permit because the level of discharge is greater than the one TBq per year criterion in our guidance. However, the impact of gaseous discharges of tritium is very low. We estimate the dose from tritium discharges to atmosphere to the group most exposed to atmospheric discharges to be 0.067μSv per year and the collective dose to the world population to be 0.021 person-Sv.

The level of gaseous tritium discharge is directly related to in-core primary circuit arisings and the control of the fuel pools. Therefore, the tritium content of gaseous discharges is also an indicator of process control, which is another reason why we propose a limit.

NNB GenCo (SZC) described how it has used operational experience modified for the UK EPR™ case to predict the ‘expected best performance’ and supports its prediction with data from the French PWR fleet and German Konvoi reactors.

NNB GenCo (SZC) described the contingencies it believes should be considered to set the limit. These include trends and events that are expected to occur such as reactor shutdown, maintenance activities, changes in the pool surface area during shutdown, coolant chemistry changes and fuel failure.

We have assessed the prediction and the contingencies and consider them to be reasonable. We consider that the NNB GenCo (SZC) proposal for a 12-rolling-month limit for gaseous discharges of tritium of 6TBq is acceptable. This is twice the limit we proposed for a single UK EPR™ in our GDA assessment.

NNB GenCo (SZC) proposed a QNL of 400GBq for a 3-rolling-month level. Its approach starts with ‘expected best performance’ and allows for normal operation fluctuations, in particular evaporation may be higher in the summer months.

In the GDA, we proposed a QNL of 150GBq for a single reactor, which we revised to 200GBq following consultation to give an adequate margin for operational fluctuations.

NNB GenCo (SZC)’s proposal is twice the GDA QNL (as there are 2 reactors) and after reviewing our GDA considerations following consultation, we have set a QNL of 400GBq for gaseous discharges of tritium in the draft permit.

6.6.2. Carbon-14

Over 80% of the carbon-14 to be discharged is expected to be degassed from the primary coolant and discharged through the gaseous waste processing system to the main stacks. Although there is operational experience indicating that there can be some hold up of carbon-14 in delay beds, due to its long half-life, there is effectively no abatement of carbon-14.

NNB GenCo (SZC) said that the 'expected best performance' per unit is 700GBq per year and proposed a limit of 1.4TBq per year. These are the same values presented in GDA, allowing for the 2 units, and they replicate the limit at Hinkley Point C.

NNB GenCo (SZC)'s proposed limit is greater than the one TBq per year threshold criterion for limit setting in our guidance. The contributions of carbon-14 to public dose and collective dose are also greater than our one μSv per year and one person-Sv threshold criteria for collective dose (for European and world populations), which also require us to set a limit. While carbon-14 contributes the most of any of the radionuclides to the impact of gaseous discharges, its impact is, in real terms, still low. We estimate the dose from carbon-14 discharges to atmosphere to the group most exposed to atmospheric discharges to be 1.2μSv per year and the collective dose to the world population to be 27person-Sv.

For GDA, we decided that an annual limit for gaseous discharges of 700GBq of carbon-14 was appropriate for a single UK EPR™. This was based on considering:

- the measures taken to reduce the production and release of carbon-14 in the reactor
- that there is no effective process for removing carbon-14 from the gaseous waste
- historic discharges at European and US PWRs
- uncertainty of the split of carbon-14 between gas and liquid phases and the level of nitrogen in the coolant

NNB GenCo (SZC) described in its application how it predicted the 'expected best performance'. Its main basis is on source terms, with production from oxygen-17 the highest, with an additional variable amount from dissolved nitrogen. Operational experience from predecessor units is not as relevant, as the UK EPR™ design is somewhat different. At Hinkley Point C, NNB GenCo said that operational feedback from operating PWR plant showed highly variable discharge levels of carbon-14. It also said that the dissolved nitrogen level in the coolant, assumed as 18ppm (parts per million) for 'expected best performance', could be higher in an operational UK EPR™. We accept that this applies to the proposed EPR™ reactors at Sizewell C. Other contingencies include unplanned shutdown and fuel failure. There is also some uncertainty about the distribution of carbon-14 between gaseous (80% assumed) and liquid phases, which NNB GenCo (SZC) says can depend on mid-cycle trips, primary coolant dilution requirements, faults in the gaseous waste processing system and the chemical and volume control system demineraliser changes.

NNB GenCo (SZC), therefore, proposed 1.4TBq per year as the limit, which includes the minor contributions from the neutron flux (‘aeroball’) monitoring system, the reactor pit atmosphere and the interim spent fuel store.

We assessed the prediction and the contingencies and accept these as reasonable. We accept NNB GenCo (SZC)’s proposal for a 12-rolling-month limit for gaseous discharges of carbon-14 of 1.4TBq per year.

NNB GenCo (SZC) applied for a QNL of 300GBq for a 3-rolling-month period. Its approach started with ‘expected best performance’ and allowed for normal operational fluctuations and possibly 100% full power operation in any quarter (the annual prediction assumes 91%). Its factor for operational fluctuations was based on analysis of data for predecessor plant between 2002 and 2009 used in the NNB GenCo application for Hinkley Point C which was updated with EDF PWR data from 2008 to 2013.

During the GDA, we proposed a QNL of 100GBq for a single reactor. We considered the information NNB GenCo (SZC) provided about fluctuations of discharge, which is more recent than that provided at GDA. NNB GenCo (SZC) has applied for a QNL of 300GBq, and we consider that this is appropriate at this stage for the 2 reactors.

6.6.3. Noble gases

NNB GenCo (SZC) states in its application that the ‘expected best performance’ is 1.6TBq per year and proposed a limit of 45TBq per year. Allowing for the 2 units at Sizewell C, these are the same values presented in GDA.

The level of discharge at the maximum is greater than the one TBq per year limit setting criterion in our guidance, so we will set a limit. However, we note the radiological impact of noble gas discharges is low. We estimate the dose from discharges of noble gases to atmosphere to the group most exposed to atmospheric discharges to be 0.14μSv per year and the collective dose to the world population to be 0.002person Sv.

The presence of noble gases in the discharge is an indicator of a fuel cladding failure and, therefore, a further reason for a limit.

For GDA, we decided that an annual limit for gaseous discharges of 22.5TBq of noble gases was appropriate for a single UK EPR™. This was based on considering:

- the better integrity expected of fuel
- reduction in discharge activity by decay in the carbon beds of the gaseous waste processing system
- historic discharges at European and US PWRs
- allowance for a level of fuel cladding failure to avoid constraining operations given that the impact of discharges is low; the dose at the generic site was 0.047μSv per year to an adult

NNB GenCo (SZC) described how it predicted the ‘expected best performance’ based on predecessor unit data. Discharges of noble gases are very variable and greatly affected by fuel issues. With no fuel leaks, discharges can be below detection levels, while, when failed fuel is present, discharges of noble gases can be an order of magnitude higher. The 'expected best performance' has been set at a very ambitious low level only achievable with no fuel leaks.

NNB GenCo (SZC) states in its application that there are 2 main contingencies to consider for the noble gas limit. One is fuel cladding failure and the other is any fault in the gaseous waste processing system, in particular any requirement to bypass the delay beds. NNB GenCo (SZC) proposed a limit of 45TBq per year. It accepted that this appeared to be a large headroom over the 'expected best performance', but data showed the significant impact fuel issues have on discharges. It chose to propose the same limit for the 1,300MWe PWR units currently operating in France, but said this was effectively a decreased limit for the UK EPR™, as its power output is some 20% higher.

We accept the prediction for 'expected best performance' and that fuel issues can significantly increase noble gas discharges. Irrespective of the benefits of BAT applied to fuel manufacture, the EPR reactors are designed to run until their next refuelling shutdown tolerant of a small level of fuel leaks and so, in setting a limit, we do not wish to constrain operations as the dose impact from noble gases is very low. In the event of leaks that may challenge the QNL, we would expect NNB GenCo (SZC) to justify continued operation with leaking fuel for the impact of all nuclides that might be released and require the operator to apply BAT to minimise all releases of radionuclides to the environment.

We accepted a limit proposal of 22.5TBq per year for a single UK EPR™ at GDA. We have considered whether it is valid to double the contingency for 2 units and decided that fuel leaks could occur on both units at the same time. Also, considering the low site-specific dose impact from noble gases (see chapter 7), we consider that NNB GenCo (SZC)'s proposal for a 12-rolling-month limit of 45TBq for Sizewell C is acceptable.

NNB GenCo (SZC) proposed a QNL for all the noble gases of 1.5TBq for a 3-rolling-month level. It looked at operational data for predecessor plant and identified that there is often a peak discharge in one month. It considered that this would be 0.607TBq for one UK EPR™. It then added 2 months at 'expected best performance' to give a 3-month level.

At GDA, we decided that a QNL of 2.25TBq for a single unit was appropriate. We based this on experience of older plant that operated with the lower levels of fuel integrity than is now expected by NNB GenCo (SZC). When we reviewed NNB GenCo (SZC)'s approach, we were content that its proposed QNL of 1.5TBq would better highlight adverse trends in disposals.

6.6.4. Iodine-131

Gaseous iodine radionuclides will degas from the primary coolant and enter the gaseous waste processing system. The recirculation of purge gas in the gaseous waste processing system will allow decay of shorter-lived iodine radionuclides such as iodine-132 and iodine-134. When purge gas is bled off, it passes through delay beds before it is discharged. While these beds are not targeted at iodine radionuclides, a delay of 40 days is claimed for iodine radionuclides. The discharge reduction factor of 40 is for iodine-131, which has a long half-life (around 8 days) compared to most of the other radionuclides of iodine. The decontamination factors for these other radionuclides will be higher. Much higher decontamination factors are achievable on systems with low flow, but we consider the delay achieved in the delay beds is BAT for this type of plant.

Iodine-131 is chosen as the indicator for all iodine radionuclides to simplify monitoring. Levels of other iodine radionuclides activity can be derived from iodine-131 monitoring if needed.

We considered the use of iodine-131 as a surrogate for all radionuclides of iodine during the GDA of the UK EPR™ and also when we reviewed British Energy Generation's radioactive substances activity permit for the Sizewell B power station in 2006. For Sizewell B, we have information that although during periods of fuel leakage the typical levels in the coolant of iodine-132 are up to 10 times higher than iodine-131, the impact from iodine-132 was low compared to the impacts of iodine-131. This is because the impact per unit activity discharged of iodine-132 is approximately 1% of the impact of iodine-131. We have set a limit for iodine-131 in the draft permit as we consider it is a suitable surrogate for all radionuclides of iodine for Sizewell C.

NNB GenCo (SZC) said that the 'expected best performance' is 50MBq per year and proposed a limit of 400MBq per year. Information was presented in GDA on total iodines. As iodine-131 is approximately 50% of total iodines, these values are equivalent.

In our assessment of the impact of iodine-131, we estimated the dose from discharges of iodine-131 to atmosphere to the group most exposed to atmospheric discharges to be 0.003μSv per year and the collective dose to be 0.0002 person Sv. We also considered the impact of total iodines, using iodine-133 to represent other iodines. We estimated the dose from discharges of total iodines to atmosphere to the group most exposed to atmospheric discharges to be 0.004μSv per year and the collective dose to be 0.0002 person Sv. Although these dose impacts are below our criteria for setting limits, we have set a limit in the draft permit, as the presence of iodine-131 in the discharge is a useful indicator of fuel leaks and the integrity of the delay beds.

For GDA, we decided that an annual limit for gaseous discharges of 400MBq of iodine-131 was appropriate for a single UK EPR™. This was based on considering:

- the better integrity expected of fuel
- reduction in discharge activity by decay in the carbon beds of the gaseous waste processing system (TEG)
- historic discharges at European and US PWRs
- allowance for a level of fuel cladding failure to avoid constraining operations given that the impact of discharges is low; the dose at the generic site was 0.039μSv per year to an adult

NNB GenCo (SZC) described how it predicted the 'expected best performance' based on data from predecessor PWRs in France. The 50MBq per year value taken may be higher than observed in reality as much of the data was shown at detection limit rather than actual measured values. Discharges of iodine radionuclides are very variable and greatly affected by fuel leaks, as with noble gases.

NNB GenCo (SZC) said there are several contingencies to consider for the iodine-131 limit. These are fuel leaks, a fault or unavailability of the gaseous waste processing system, unpredictable release from pipes and faults in the iodine traps. NNB GenCo (SZC) proposed a limit of 400MBq per rolling year to provide headroom over the 'expected best performance' to allow for the contingencies. It supported its proposal by reference to peaks in the data from predecessor PWRs.

We consider that the prediction for 'expected best performance' is acceptable and that fuel issues and other contingencies require sufficient headroom to be added to that value to give the limit. We consider that the NNB GenCo (SZC) proposal for the gaseous iodine-131 12-rolling-month limit to be 400MBq for Sizewell C is acceptable. This is actually less than that we proposed at GDA, as there we used the predicted maximum, 400MBq for one UK EPR™ for total iodines, as the limit for iodine-131 alone.

NNB GenCo (SZC) proposed a QNL of 64MBq for a 3-rolling-month level. It looked at operational data for predecessor plant (for all French N4 design PWRs 2004 to 2009, and French EDF plant 2008 to 2013) and identified that there is often a peak discharge in one month. It considered this normal variability would be 28MBq for one UK EPR™. It then added 2 months at 'expected best performance' to give a 3-month level.

In the GDA, we proposed 40MBq for a single reactor. We consider that NNB GenCo (SZC)'s proposal is based on a better estimate from operational experience and have set a QNL of 64MBq, as was done for Hinkley Point C.

6.6.5. Fission and activation products associated with particulate matter – caesium-134, caesium-137, cobalt-58 and cobalt-60

Fission and activation products are present in the reactor coolant and can be in aerosols produced from equipment leaks or as the coolant is treated, in the chemical and volume control system (CVCS). In the draft permit, we term these fission and activation products as 'beta emitting nuclides associated with particulate matter'.

Most fission and activation products in the primary coolant remain in the liquid phase. Aerosols from equipment leaks are picked up by the ventilation systems, which have HEPA filters that should effectively remove the aerosols before discharge to the main stack. Fission and activation products can be in the gaseous effluent from the CVCS to the gaseous waste processing system. The gaseous effluent from the gaseous waste processing system passes through HEPA filters before discharge to the main stack.

In our assessment of the impact of all the other radionuclides taken together, we estimated the dose from discharges of other radionuclides to atmosphere to the group most exposed to atmospheric discharges to be 0.03μSv per year and the collective dose to be 0.0007 person Sv. Both doses are less than our criteria for setting a limit, so, on the basis of dose alone, we do not need to set a limit. However, we consider that these radionuclides act as an indicator of plant performance and therefore require a limit in the permit.

NNB GenCo (SZC) said that the 'expected best performance' for other fission and activation products is 8MBq per year and proposed a limit of 120MBq per year. These are the same values EDF and AREVA submitted at GDA and were used for Hinkley Point C.

The presence of fission products, mainly caesium-134 and 137, and activation products, mainly cobalt-58 and 60, in the discharge would be an indicator of faults in the HEPA filtration system and fuel.

For GDA, we decided that an annual limit for gaseous discharges of 50MBq for other radionuclides was appropriate for a single UK EPR^{TM}. This was based on considering:

- the measures taken to reduce the creation and discharge of other radionuclides
- historic discharges at European and US PWRs
- that the impact of discharges is low; the dose at the generic site was 0.018μSv per year to an adult

NNB GenCo (SZC) described how it predicted the 'expected best performance' based on data from predecessor PWRs in France. The 8MBq per year value is more a sum of detection thresholds as most measurements were below detection limits of the monitoring instrumentation.

We have set an annual limit of 120MBq in the draft permit.

NNB GenCo (SZC) suggested a QNL of 58MBq for a 3-rolling-month level may be appropriate. It looked at operational data for predecessor plant and identified that there is often a peak discharge in one month. It considered this would be 28.4MBq for one UK EPR^{TM}. It then added 2 months at 'expected best performance' to give a 3-month level. However, in line with Environment Agency feedback reflected in the permit at Hinkley Point C, NNB GenCo (SZC) applied for a QNL of 8MBq.

We considered a lower QNL to be appropriate because we expect the limits of detection of the measuring equipment to be a large portion of the measured result. Small changes in discharges or the limits of detection can have a large impact on the measured discharge. Therefore, we have allowed for an event leading to discharges of 75% of the annual expected best performance in one month, with this unit and the other unit operating at best performance for the rest of the period.

In making our assessment of beta emitting radionuclides associated with particulate matter, we considered leakage from the primary circuit to the secondary circuit and the potential that could lead to gaseous discharges of both fission products and actinides from the steam vents. We considered the removal of particulate matter from the primary circuit at GDA and are satisfied that the CVCS will remove particulate matter from the primary circuit. Furthermore, leakage to the secondary circuit is likely to be very low due to the integrity of the components and will primarily involving tritium diffusion. We consider that this is not a credible route for discharge of fission and activation products.

6.6.6. Gaseous discharges – summary of estimated best performance, proposed annual limits and proposed quarterly notification levels

We have produced a table (6.2) showing NNB GenCo (SZC)'s values of estimated best performance, its proposals for annual limits and quarterly notification levels and our proposals for limits and QNLs which have been included in our draft Sizewell C permit.

Table 6.2 Best estimated performance and proposed site limits: gaseous discharges

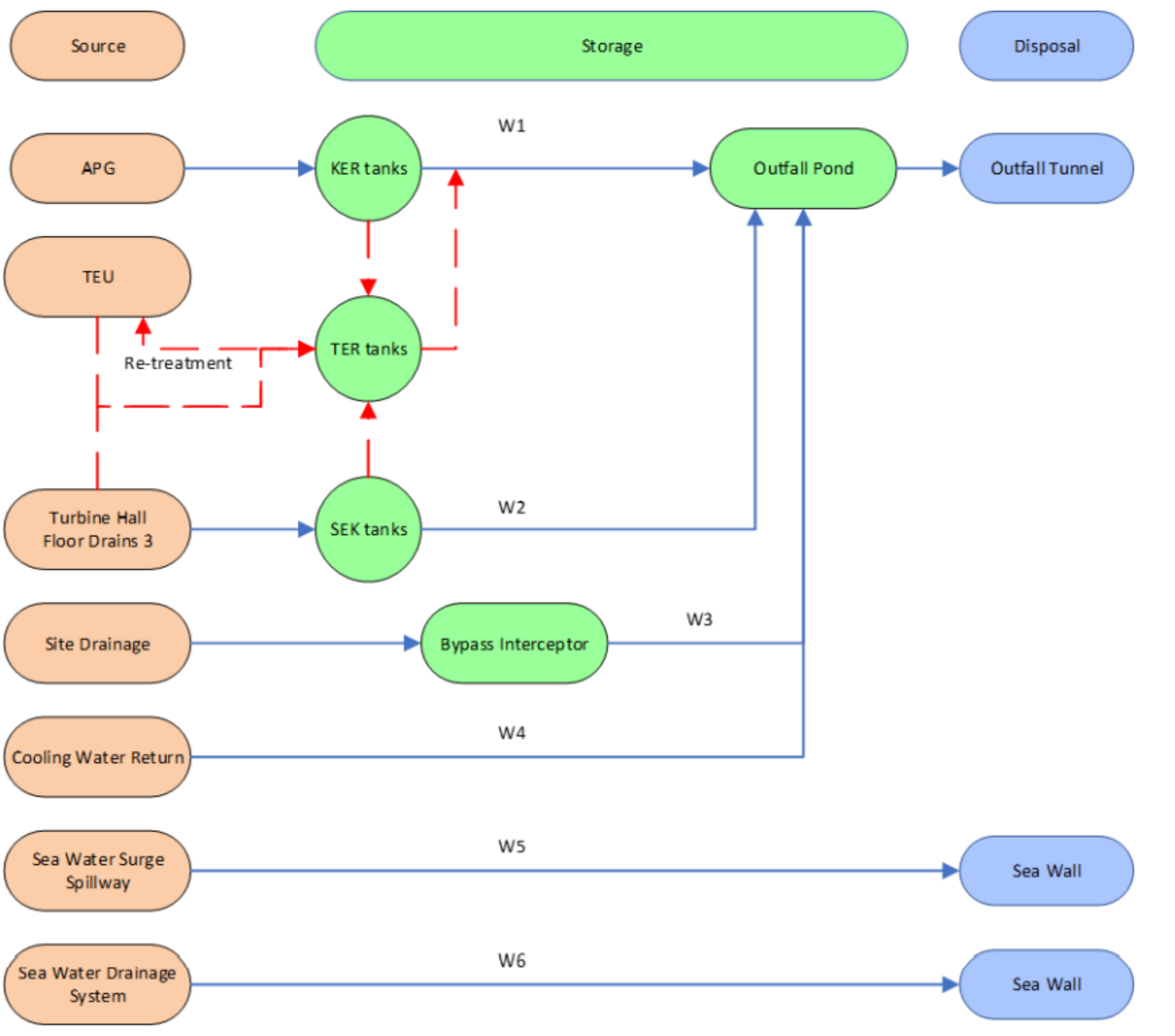
Radionuclides	Estimated best performance (GBq/year) for one unit	Proposed annual limit (GBq/year)	Proposed annual limit (GBq/year)	Proposed quarterly notification level (GBq/year)	Proposed quarterly notification level (GBq/year)
		NNB GenCo (SZC)	Environment Agency	NNB GenCo (SZC)	Environment Agency
Tritium	1,000	6,000	6,000	400	400
Carbon-14	700	1,400	1400	300	300
Noble gases	1,600	45,000	45,000	1,500	1,500
Iodine-131	0.05	0.4	0.4	0.064	0.064
Other fission and activation product gasses	0.008	0.12	0.12	0.008	0.008

6.7. Systems for the discharge of aqueous radioactive waste to the environment

The main source of aqueous radioactive discharges would be from the treatment of primary coolant. Additionally, some aqueous waste is produced by the liquid waste processing system (TEU) collecting equipment drainage, leakage or floor washings that could be contaminated with radioactivity.

In Figure 6.2 we have reproduced Figure 7.9 from Support Document A2 of NNB GenCo (SZC)'s application, 'Summary of discharge routes from Sizewell C site'. This provides a visual indication of the sources of aqueous waste, where that waste is stored and processed and its ultimate discharge route.

Figure 6.2 Summary of aqueous discharge routes from Sizewell C



The liquid waste processing system takes effluent from the various sources initially into buffer storage tanks. NNB GenCo (SZC) would then use filtration, ion exchange or evaporation, as appropriate, to minimise the radioactivity content before effluent is collected in a set of discharge tanks (3 tanks, each of 750m^3 capacity). Tank contents are analysed for acceptability to discharge and, if they meet the criteria, they are then discharged through outlet W1 under a management system to the outfall pond where there is initial dilution in the returning cooling water, which passes at a minimum of 116m^3/second.

Another potential, but minor, source of radioactivity is drainage water from the turbine hall, including drainage from the secondary circuit. This is collected in separate discharge tanks (2 tanks each of 750m^3 capacity), for acceptability analysis before disposal to the outfall pond through outlet W2.

At Sizewell C one liquid waste processing system would handle the liquid effluent from both units, and the discharge tank system is common. The outfall pond would discharge into the North Sea through a tunnel, with its outfall some 3.5km offshore. We have assessed that the aqueous discharge arrangements contribute to BAT (see section 5.5).

The discharge system includes some reserve tanks (3 tanks, each of 750m^3 capacity). These tanks can discharge to the outfall pond through outlet W2, but also the contents can be circulated into the liquid waste processing system, if required. There are other drainage systems (W3-W6 in Figure 2) that have little potential for radioactive contamination.

NNB GenCo (SZC) has allocated disposal outlet references W1 to W6 as shown in Figure 6.2. Most of the radioactivity discharged would be in discharges from the KER tanks, which would be continually proportionally sampled at outlet W1. Outlets W2 would also have proportional sampling (see section 6.13.4 of this document). The other outlets, W3 to W6, are proposed to be sampled intermittently as no contamination by radioactivity is expected (see section 7.2.5 of the application Support Document A2). We have chosen not to set individual limits for these outlets but have specified in the draft permit that total discharges from these shall not exceed 5% of the relevant site annual limits.

6.8. Aqueous radioactive discharge limits

The Standardised Reporting of Radioactive Discharges Direction 2018 (UK Parliament, 2018b) defines (with reference to EU Commission Recommendation 2004/2/Euratom) 39 radionuclides for consideration in liquid discharges. These are listed in Table 3-2 of the application Support Document B (Discharge Limits for Radioactive Waste). We identified those that are significant in terms of:

- quantity
- contribution to site discharges
- dose to the representative persons
- collective human dose
- importance as indicators of plant performance or process control
- dose to environmental receptors

Those identified were tritium, carbon-14, cobalt-60, caesium-137, and ‘other nuclides’ as a single group.

NNB GenCo (SZC) has applied for the same radioactive discharge limits as we granted for NNB GenCo (HPC) at Hinkley Point C.

6.8.1. Alpha emitters

As in the GDA and at Hinkley Point C, we have not included alpha emitters. We considered alpha emitters at GDA and decided that they did not need detailed consideration as the discharges and impacts were very low. We note that plutonium-241 is not an alpha emitter but does decay to americium-241. However, the quantities of both are not significant.

NNB GenCo (SZC) stated that alpha emitters would not be detectable in liquid effluent. This is in line with our assessment at GDA and, although we have not set a limit in the draft permit, we will require assessment for alpha emitters for individual and bulked samples through the permit. For bulked samples, more sensitive methods can be applied. We will require results to be reported to us and we will make them available on the public register.

6.8.2. Tritium

Tritium waste originates in the primary coolant generally as tritiated water and the majority of tritium is discharged as aqueous effluent. NNB GenCo (SZC) stated that disposal to the marine environment produces a lower impact than gaseous discharges. This is supported by information in its dose assessment, and our independent assessment has confirmed this. Therefore, we consider that the discharge of tritium as liquid effluent in preference to gaseous effluent contributes to BAT.

For the GDA, we decided that an annual limit for aqueous discharges of 75TBq of tritium was appropriate for a single UK EPR™. This was based on considering:

- the measures taken to reduce the production and release of tritium in the reactor
- there is no effective process for removing tritium from the aqueous waste
- the impact of discharges is low; the dose at the generic site was 0.14µSv per year to an adult
- historic discharges at European and US PWRs

NNB GenCo (SZC) said that the ‘expected best performance’ is 104TBq per year for the 2 units at Sizewell C and proposed a limit of 200TBq per year. Allowing for the presence of 2 units rather than one considered in GDA, the ‘expected best performance’ per unit is simply the same value presented in GDA. The proposed limit is higher than twice our proposed indicative annual limit in the GDA, but is aligned to the approved limit granted at Hinkley Point C.

We have set a limit for tritium in the draft permit as the level of discharge is greater than the one TBq per year criterion in our guidance. However, the impact of aqueous discharges of tritium is very low; we estimated the dose from aqueous tritium to the group most exposed to liquid discharges to be 0.006µSv per year and the collective dose to the world population to be 0.007 person Sv.

NNB GenCo (SZC) considered that a limit higher than twice the single unit maximum annual discharge is necessary. This is because tritium accumulates in the reactors until towards the end of the 18-month fuel cycle when there are higher rates of liquid discharges of primary coolant to reduce its boron content to maintain reactivity. At Hinkley Point C we accepted NNB GenCo (SZC)’s argument that allowance should be made for 2 planned and one possible unplanned outage occurring within one rolling 12-month period.

We consider that this is an infrequent but possible sequence of events that was not considered when the GDA limits were proposed for a single unit and a calendar year. We consider it would be unreasonable to restrict the operation of the power station by imposing a limit that was inappropriately low and have accepted NNB GenCo (SZC)’s argument for a limit of 200TBq for Sizewell C.

NNB GenCo (SZC) proposed a QNL of 60TBq. At GDA, we considered a QNL of 45TBq to be appropriate for one unit based on the 3 months of higher discharges that occur before an outage. For 2 units, we have taken this QNL for a single unit along with the addition of one quarter of the ‘expected best performance’ (that is, 52TBq divided by 4 and rounded up) of 15TBq for the other unit. This is consistent with the limits imposed at Hinkley Point C and we therefore accept that a QNL of 60TBq is appropriate for Sizewell C.

We would keep these limits and notification levels under review in the light of operational experience.

6.8.3. Carbon-14

NNB GenCo (SZC) said that up to 20% of carbon-14 produced in the primary coolant can be discharged as aqueous effluent. Some carbon-14 will be retained in filters, ion exchange resins and in evaporator concentrate, but this is not the main purpose of those techniques.

NNB GenCo (SZC) said that the ‘expected best performance’ is 46GBq per year and proposed a limit of 190GBq per year. Allowing for the 2 units at Sizewell C, these are pro rata the same values presented in GDA.

Carbon-14 contributes the most of any of the radionuclides to the impact of aqueous discharges. We estimated the dose from aqueous carbon-14 to the group most exposed to liquid discharges to be 3.59µSv per year and the collective dose to the world population to be 2.3person-Sv. Both the dose to the group most exposed to liquid discharges and the collective dose to the world population are above our criteria for setting a limit, therefore we have set one.

For GDA, we decided that an annual limit for aqueous discharges of 95GBq of carbon-14 was appropriate for a single UK EPR^{TM}. This was based on considering:

- the measures taken to reduce the production and release of carbon-14 in the reactor
- that there is no effective process for removing carbon-14 from the aqueous waste
- historic discharges at European and US PWRs
- uncertainty of the split of carbon-14 between gas and liquid phases and the level of nitrogen in the coolant

NNB GenCo (SZC) said that the ‘expected best performance’ is based on data from the 1,300MWe plant currently operating in France, modified for the output of the UK EPR^{TM}. It said that this is similar to a value calculated as 5% of the source term. It provided calculated data against measured discharges that shows wide variance between the two and said accurately predicting discharges is complex, as the behaviour of carbon-14 in the plant is affected by its chemical form and that form may change.

NNB GenCo (SZC) provided information on the contingencies affecting aqueous discharges of carbon-14: its main concern was the uncertainty in the partitioning of carbon-14 between the gaseous and liquid phases. It proposed to base its maximum on

20% carbon-14 in the liquid phase, giving 190GBq per year. Other contributing factors were high nitrogen content in the primary coolant, unplanned shutdown, and contamination of fuel pools. This maximum includes sufficient margin to cover these contingencies.

The discharge of carbon-14 would follow the same pattern as tritium, with the majority discharged in the months before shutdown because carbon-14 accumulates in the reactors circuit until towards the end of the 18-month fuel cycle when there are higher rates of liquid discharges of primary coolant to reduce its boron content to maintain reactivity. However, on considering the effect of the 2 units on the 12-rolling-month total discharge, NNB GenCo (SZC) said there should be no impact, and put forward 190GBq per year, as the proposed limit.

The prediction for 'expected best performance' and justification for the proposed limit are the same as we assessed and accepted in GDA. We consider that NNB GenCo (SZC)'s proposal for the aqueous carbon-14 12-rolling-month limit to be 190GBq for Sizewell C is acceptable.

NNB GenCo (SZC) has applied for a QNL of 9GBq for a 3-rolling-month level per reactor. We proposed during the GDA a QNL of 9GBq for a single reactor, which was based on a higher discharge in one month. We consider a QNL of 18GBq to be appropriate for Sizewell C.

6.8.4. Other fission and activation products (including caesium and cobalt)

Activated corrosion products and other fission products would be present in primary coolant sent to the TEU (liquid processing system) for treatment and disposal. Abatement techniques in the TEU include filtration, ion exchange and evaporation. We have considered how these contribute to BAT in section 5.4.

NNB GenCo (SZC) proposed limits and QNLs in its submission for cobalt-60, caesium-137 and 'other fission and activation products' in section 4.5 (page 134) of its Head Document, with supporting information in Support Document B section 5.6.1, 5.6.2 and 5.6.3 respectively.

We have assessed the information NNB GenCo (SZC) provided in light of our GDA assessment of the EPR™ reactor. Allowing for the proposal for 2 units at Sizewell C, the values applied for are based on the values presented in GDA and are consistent with the permit granted at Hinkley Point C. For aqueous discharges of fission and activation products we have taken into account the sources, expected discharges, and impacts. Using our criteria for limit setting we have decided to set specific limits for cobalt-60 and caesium-137. Cobalt-60 is an indicator of lack of corrosion control and/or failure of treatment in the liquid waste processing system. Caesium-137 is an indicator of fuel failure.

Cobalt-60

NNB GenCo (SZC) said that the 'expected best performance' for cobalt-60 would be 395MBq/year and proposed a limit of 6GBq/year. NNB GenCo (SZC) proposed a limit for this radionuclide based on the GDA information and, for 2 units. We reviewed these figures in GDA and again in the Hinkley Point C application. We consider that an annual limit of 6GBq is also appropriate for Sizewell C.

We estimated the dose from aqueous cobalt-60 to the group most exposed to liquid discharges to be 0.1μSv per year and the collective dose to the world population to be 0.0003 person-Sv.

We considered the methods NNB GenCo (SZC) used to propose a QNL in section 5.6.1 of Support Document B of its submission. NNB GenCo (SZC)'s method leads to a QNL of 0.3GBq. Taking into account the variation in expected performance and the potential contribution of minimum detectable activity results, we consider that this is an appropriate value for the QNL.

Caesium-137

At GDA, we set an annual limit for one UK EPR™ of 0.5GBq. This would lead to a limit of one GBq. NNB GenCo (SZC) said that the 'expected best performance' for caesium-137 is 114MBq per year and proposed a limit of 1.9GBq per year.

We estimated the dose from aqueous caesium-137 to the group most exposed to liquid discharges to be 0.006μSv per year and the collective dose to the world population to be 0.0002 person Sv.

We consider that the additional information NNB GenCo (SZC) provided in the application based on recent PWR operational experience of similar reactors, allowing for the transfer of experience to the planned EPR operating regime, justifies a limit of 1.9GBq.

NNB GenCo (SZC) proposed a QNL of 0.11GBq. We consider that given the variations in expected performance and the potential contribution of minimum detectable activity results to the measured discharge, a QNL of 0.1GBq is appropriate.

We would keep these limits under review in the light of operational EPR experience.

Other radionuclides

NNB GenCo (SZC) said that the 'expected best performance' for 'other fission and activation products' (excluding caesium-137 and cobalt-60) is 804MBq per year and proposed a limit of 12GBq per rolling year.

NNB GenCo (SZC) initially proposed a QNL of 1.0GBq for other fission and activation products following the approach taken at Hinkley Point C. However, at Hinkley Point C we set a QNL of 0.6 and consider that is appropriate for Sizewell C. NNB GenCo (SZC) has applied for a QNL of 0.6GBq for other radionuclides (as a group).

Iodines tend to dissolve and are, therefore, mostly found in aqueous effluents. While it is not their main function, the demineralisers in the coolant purification system do absorb significant amounts of iodine if it is present in the effluent. Also, effluents are held up in tanks in the liquid waste processing system awaiting treatment or discharge. The delays would allow most of the shorter half-life iodine radionuclides to decay. Due to the short half-life of the other radionuclides of iodine, we consider iodine-131 as a suitable representative for the whole group of iodine radionuclides potentially in discharges.

For GDA, we decided that an annual limit for aqueous discharges of iodine-131 was not appropriate for a single UK EPR^{TM}. This was based on considering:

- improved fuel integrity
- removal in demineralisers
- historic discharges at European and US PWRs
- low level of discharge, a maximum of 50MBq per year
- the impact of discharges is very low, the dose at the generic site was 0.000076μSv per year to an adult

We do not propose to set an iodine-131 aqueous discharge limit for Sizewell C as the predicted discharges do not meet any of our limit setting criteria, therefore aqueous iodine discharges will be limited by the other radionuclides limit.

In our assessment of the impact of all the other radionuclides taken together, we estimated the dose to the group most exposed to liquid discharges to be 0.013μSv per year and the collective dose to be 0.0009person-Sv. Both doses are less than our criteria for setting a limit, so, on the basis of dose alone, we do not need to set a limit. However, we consider that these radionuclides require limits in the draft permit to act as indicators of plant performance and therefore should be subject to control. We propose to set a limit that will be based on a method of measurement designed to detect a wide range of radionuclides.

6.8.5. Aqueous discharges – summary of estimated best performance, proposed annual limits and proposed quarterly notification levels

We have set out in Table 6.3 the operator's estimates of best estimated performance, limits and QNLs applied for alongside our proposed limits. These limits are reflected in our permit for Sizewell C. The limits on disposals of aqueous radioactive waste are set out in Schedule 3 of the draft permit.

6.9. Future gaseous and aqueous discharge limits

We would review limits in future in light of the performance of the UK EPR^{TM}. It may then be appropriate to reduce the contingency built into the limits. We would consider the government's statutory guidance on radioactive discharges to the Environment Agency at any future reviews.

There is an overriding requirement for operators to use BAT that applies below any limit we set, and it is through this requirement that we continue to expect best performance and assure ourselves discharges are minimised and that doses to the public and environment remain 'as low as reasonably achievable' (ALARA), taking social and economic factors into account.

Table 6.3 Best estimated performance and proposed limits: aqueous discharges

Radionuclide	Estimated best performance (GBq/year)	Proposed annual limit (GBq/Year)	Proposed annual limit (GBq/Year)	Proposed quarterly notification level (GBq/Year)	Proposed quarterly notification level (GBq/Year)
		NNB GenCo (SZC)	Environment Agency	NNB GenCo (SZC)	Environment Agency
Tritium	104,000	200,000	200,000	60,000	60,000
Carbon-14	46	190	190	18	18
Cobalt-60	0.395	6	6	0.3	0.3
Caesium-137	0.114	1.9	1.9	0.1	0.1
Other fission and activation products (excludes tritium, carbon-14 and caesium-137)	1.2	12	-	0.6	-
Other fission and activation products (excludes tritium, carbon-14, cobalt-60 and caesium-137)	0.804	-	12	-	0.6

6.10. Disposals by burial in an engineered facility on the site

NNB GenCo (SZC) has not applied to dispose of wastes by burial on the site.

6.11. Transfers of radioactive waste

We require all operators to:

- minimise the amount of radioactive waste generated
- minimise discharges of that radioactive waste to the environment

This results in radioactive wastes preferentially being in the form of solid waste (the ‘concentrate and contain’ principle) which will require disposal either on-site or by transfer to other suitably permitted sites for treatment or disposal as appropriate.

We do not routinely set limits on transfers of radioactive waste to other sites as those sites must be permitted and any transfers must comply with the waste acceptance criteria for the receiving site.

In accordance with government policy on the management of solid low level waste, the draft permit contains a number of standard provisions to facilitate the disposal of low level waste in accordance with the waste hierarchy. You can find further information about the disposal of solid low level waste in:

- Policy for the long-term management of solid low level radioactive waste in the United Kingdom (UK Parliament, 2007)
- UK Strategy for the Management of Solid Low Level Radioactive Waste from the Nuclear Industry (UK Parliament, 2016b)

The draft permit contains standard conditions (3.1.1 to 3.1.6) in relation to the transfer of radioactive waste, which require the waste to be properly characterised and all relevant information to be made available to potential consignees, so that they are informed about the nature of the radioactive waste and only accept such wastes as they are permitted to receive.

6.12. Receipt of waste

NNB GenCo (SZC) has not applied to be able to receive radioactive waste from other sites. However, the draft permit does include a standard condition (3.1.7) which allows NNB GenCo (SZC) to receive returned samples and waste.

NNB GenCo (SZC) did not include any further information on the receipt of waste because it only expects to receive returned samples, waste returned to the site in accordance with draft permit condition 3.1.7 or waste collected as a result of any future participation in the National Arrangements for Incidents involving Radioactivity (NAIR) or the RADSAFE scheme.

The draft permit contains standard conditions (for example, 2.6.1) requiring the operator to provide information to potential consignors about waste that can be accepted under this permit to ensure that consignors only send waste that the operator can receive.

6.13. Monitoring

We assessed NNB GenCo (SZC)’s proposals for in-process, discharge and disposal, and environmental monitoring (as outlined in chapter 5 of the application’s Head Document and in more detail in Support Documents C1 and C2). NNB GenCo (SZC) notes that:

“As the SZC project develops, SZC Co. will demonstrate that the specification of equipment to fulfil the monitoring arrangements are BAT based on the application of relevant codes and standards recognised as relevant good practice. During the procurement process SZC will continue to monitor the development of equipment supply to ensure equipment meets all specified requirements and that installation is completed successfully ensuring that the BAT criteria established is not compromised. The 'Forward Work Plan' (FWP) (in section 5 of Support Document C1) details the further work required to demonstrate that monitoring systems remain BAT during the design, procurement and construction process through the production of system level BAT assessments as well as supporting documentation (such as techniques documents) to be completed as the process towards operations continue."

We accept that this work is outstanding and will be completed after the permit if it is granted. We have included information/improvement conditions in the draft permit (see sections 6.13.1 to 6.13.6) to make it a specific requirement to complete this work.

The following sections (6.13.1 - 6.13.6) outline NNG GenCo (SZC)'s proposals for monitoring concerning in-process monitoring, discharges and disposals and environmental monitoring and our assessment of these.

6.13.1. In-process monitoring

In-process monitoring of radioactive effluent is expected to cover the radionuclides and groups of radionuclides identified as significant for discharge limits. Other radionuclides may be monitored periodically to provide further trending of plant performance. We have reviewed NNB GenCo (SZC)'s proposals in its application.

Plant radiation monitoring systems are planned for gaseous and liquid effluents. For liquid effluents, these provide information to enable suitable segregation, treatment and storage. For gaseous effluents, they ensure suitable treatment and verification of abatement performance. In both cases, operational data for trending would be provided.

All systems containing environmental protection equipment and crucial environmental protection equipment would undergo plant monitoring to ensure and verify the availability and effectiveness of the equipment to carry out its environmental protection function. Conditions such as temperature, pressure and flow would be monitored throughout the plant and are considered integral to the systems they serve.

We have included an information/improvement requirement, IC 19, in the draft permit that requires NNB GenCo (SZC) to provide us with a report that demonstrates that in-process monitoring is BAT.

6.13.2. Discharge and disposal monitoring

We assessed NNB GenCo (SZC)'s proposals for discharge monitoring and consider that it is proposing to follow our guidance and has an appropriate Forward Work Plan to ensure that monitoring will use BAT. We would review its progress against its plan.

NNB GenCo (SZC)'s Forward Work Plan provides the following commitment:

- commitment 4 – Monitoring: NNB GenCo (SZC) will provide to the Environment Agency details of the specifications of the liquid, gaseous and solid radioactive waste monitoring, sampling and analytical equipment used to demonstrate compliance with the limits and conditions of the RSR permit. This applies to both discharge and in-process monitoring

We have included 3 further information/improvement requirements, IC 5, IC 6 and IC 7 in the draft permit to formally allow us to assess NNB GenCo (SZC)'s progress at appropriate stages of the development of sampling and monitoring systems.

6.13.3. Gaseous discharge monitoring

NNB GenCo's application states that gaseous wastes would be collected together for discharge by the main stack (see section 6.5) and monitoring of these discharges would be performed in accordance with relevant national and international standards and regulatory and industry guidance. Other features of the gaseous discharge monitoring proposed by NNB Genco (SZC) include:

- primary sampling lines located in the stack would be routed to a sampling room and a combination of on-line analysers and samplers. These would allow for beta gas monitoring, on-line gamma monitoring and via 3 secondary sampling lines, the collection of particulate and iodine-131, tritium and carbon-14 samples
- a second set of sampling lines routed to a separate room with duplicated equipment would be available to allow for redundancy in discharge monitoring/accountancy and Environment Agency independent monitoring as required
- the location of sampling points, and properties of the sampling nozzles and lines are designed to ensure representative samples (gaseous and particulate) would be taken
- the required effluent flow monitoring would also be carried out
- the use of equipment sufficiently sensitive to demonstrate compliance with proposed limits and ensure the levels of detection as specified in the Standardised Reporting of Radioactive Discharges Direction 2018 (UK Parliament, 2018b) are met, where relevant
- there are no plans to continuously monitor minor gaseous outlets, these discharges will be assessed based on process data and/or spot sampling

We consider that the information NNB GenCo (SZC) provided on the sampling and analytical techniques it plans to use would provide representative results with appropriate limits of detection, taking account of government directions, international best practice and relevant standards, and would represent BAT. We will review the submissions NNB GenCo (SZC) made for information/improvement requirements, IC 5, IC 6 and IC 7 to ensure BAT is being applied.

6.13.4. Liquid discharge monitoring

NNB GenCo (SZC) states in its application that monitoring in accordance with relevant national and international standards and regulatory and industry guidance would be carried out on each main aqueous discharge outlet (W1 and W2) for tritium, carbon-14, cobalt-60, caesium-137 and 'other radionuclides' as the effluent is discharged. Monitoring of the effluent tanks would also be carried out prior to release to ensure the suitability of the effluent for discharge. Other features of the liquid discharge monitoring proposed by NNB GenCo (SZC) include:

- online radiation detectors to continuously measure gamma activity on the discharge line to identify and stop abnormal discharges. In the event the pre-determined threshold is met, the final isolation valve would close preventing further discharge
- a constant volume variable time flow proportional sampler for sampling during discharge to provide a sample representative of the entire discharge for subsequent laboratory analysis and statutory reporting of results. NNB GenCo (SZC) has given due consideration to the location and properties of the flow proportional sampler and flow meter to allow for representative samples to be taken. No duplicate flow proportional sampling system is intended as NNB GenCo (SZC) states a robust maintenance strategy will be in place. Back-up measurements, in case of failure, will be from the tank monitoring system. Environment Agency independent sampling, as required, would be from the flow proportional sampler
- effluent flow monitoring carried out using an MCERTS accredited flow meter
- the use of equipment sufficiently sensitive to demonstrate compliance with proposed limits and ensure the levels of detection as specified in the Standardised Reporting of Radioactive Discharges Direction 2018 (UK Parliament, 2018b) are met, where relevant

We consider that the information NNB GenCo (SZC) provided on the sampling and analytical techniques it plans to use would provide representative results with appropriate limits of detection, taking account of government directions, international best practice and relevant standards and would represent BAT. We will review the submissions NNB GenCo (SZC) made for information/improvement requirements IC 5, IC 6 and IC 7 to ensure BAT is being applied.

6.13.5. Solid waste monitoring

NNB GenCo (SZC)'s plans for solid waste monitoring fall under 2 categories:

- sentence monitoring: used as an input to characterise the waste package for transfer off-site for treatment/disposal
- in-process monitoring: provides information to inform solid radioactive waste management decisions (for example, changing a filter)

In the application, waste streams have been identified, along with the proposed approach to monitoring. In most cases, this would be based on the use of a scaling methodology or, in limited cases, (for example, for oils and solvents) on destructive analysis.

We have assessed NNB GenCo (SZC)'s proposals for solid waste monitoring and consider that it is proposing to follow our guidance and has an appropriate Forward Work Plan to ensure that monitoring will represent BAT. If a permit is granted, we would review the submissions made for information/improvement requirements, IC 5, IC 6 and IC 7 and monitor progress against its Forward Work Plan as part of our regulation to ensure BAT is applied.

6.13.6. Environmental monitoring

We have assessed NNB GenCo (SZC)'s proposals for environmental monitoring in Support Document C2 of the application, which are currently at an outline level, but conclude that it is proposing to follow the principles in our guidance and has an appropriate Forward Work Plan to implement BAT for environmental monitoring.

NNB GenCo (SZC)'s Forward Work Plan in the application contains Commitment 5 regarding its environmental radioactivity monitoring programme. This includes:

- developing and maintaining an environmental monitoring programme on appropriate project timescales
- reviewing environmental radioactivity monitoring data and considering what, if any, additional sampling and monitoring may be required to establish a pre-operational baseline of environmental radioactivity around the site
- developing a risk-informed schedule of routine environmental radioactivity monitoring requirements accompanied by a BAT justification, along with a techniques document in accordance with the condition of the RSR permit

Important pathways and receptors must be included in the proposed environmental monitoring programme. The protection of wildlife is also covered in the objectives within our guidance on environmental monitoring and we expect NNB GenCo (SZC) to consider these objectives within its proposed environmental monitoring programme.

We would expect NNB GenCo (SZC)'s environmental monitoring programme to begin at least 2 years ahead of permitted operations, and in any case, monitoring will be required to start prior to active commissioning of systems before any discharges of radioactive effluents take place.

We will require NNB GenCo (SZC) to provide a report on its proposed environmental monitoring programme to ensure that it met our expectations in advance (30 months) of the commissioning of relevant plant. We have included this issue as an information/improvement condition requirement IC 16 in the draft permit.

7. Our assessment – part 4: Assessment of radiation doses to people and dose rates in the environment

In this section, we present the assessment of the radiological impact on people and wildlife from the proposed discharges from Sizewell C. We have carried out an independent assessment with contractor support and have produced a full report of our assessment (Environment Agency, 2022), which is available on our consultation hub. The Food Standards Agency (FSA) also assessed the impacts on people through the food chain and provided the outcome of this in its response to our consultation.

7.1. Radiological assessment: impact on people

We assess doses to members of the public from discharges at the proposed limits set out in the application and compare them with the statutory requirements specified in Schedule 23 Part 4 Section 1 of EPR 2016. Under EPR 2016 we have a duty to ensure operators keep exposures as low as reasonably achievable (ALARA), taking social and economic factors into account, and to ensure that the dose limits in the Basic Safety Standards Directive (BSSD) Article 12 are not exceeded. The criteria we use to achieve this are:

- a restriction on the annual dose to an individual from a **single source** such that when combined with doses from all sources, excluding natural background and medical procedures, the dose limit is not likely to be exceeded. A source constraint of 300μSv/y has been set in Schedule 23 Part 4 Section 1 of EPR 2016
- a restriction on annual dose to an individual from a **single site** such that when combined with doses from all sources, excluding natural background and medical procedures, the dose limit is not likely to be exceeded. A site constraint of 500μSv/y has been set in Schedule 23 Part 4 Section 1 of EPR 2016. This applies to the aggregate exposure from a number of sources with contiguous boundaries at a single location, irrespective of whether different sources on the site are owned or operated by the same or by different organisations
- the **public dose limit** of 1,000μSv/y as set out in Schedule 23 Part 4 Section 1 of EPR 2016

Our assessments of dose use realistic assumptions about the behaviour and dietary patterns of representative members of the exposed public wherever data are available and otherwise conservative assumptions. Our radiological assessments of doses to the public from future discharges are based on the behaviour and concentrations of radionuclides once they are in the environment. We conservatively assume that discharges are made at 100% of the proposed discharge limits for the proposed operational lifetime of the power station.

In accordance with our dose assessment principles (Environment Agency and others, 2012) we calculate the dose to the 'representative person'. The representative person is an individual receiving a dose that is representative of those members of the public who are estimated to receive the highest dose overall (from discharges to atmosphere, aqueous discharges and direct radiation from the site). The dose to the representative person is then compared with the dose constraints and dose limit. Where doses are separately assessed for different types of discharges, the term 'group most exposed to' is used. The dose to the representative person may be less than the total of all the doses to the 'groups most exposed' as the representative person may not be a member of all the most exposed groups. It is unrealistic to sum the doses received by 2 different groups.

Our assessment takes account of projected doses from direct radiation from the Sizewell C site, discharges from nearby sites and the residue of past discharges from the nearby nuclear sites Sizewell A and Sizewell B. Our assessment used our screening tool IRAT (Initial Radiological Assessment Tool) and the PC-CREAM software tool together with information on people's habits from local studies.

7.1.1. NNB GenCo (SZC)'s assessment – impact on people

NNB GenCo (SZC) provided a radiological impact assessment at the discharge limits requested in the application (Support Document D1). NNB GenCo (SZC)'s assessment used a staged approach. Its initial assessments using our IRAT approach indicated the need for a more detailed assessment. We verified the results of NNB GenCo (SZC)'s initial assessment and agreed a more detailed assessment was needed.

NNB GenCo (SZC) assessed:

- doses to the representative person from continuous discharges to atmosphere and to the sea
- doses to the representative person from external exposure to direct radiation from the site infrastructure
- doses from short-term discharges to the atmosphere
- collective doses to UK, European and worldwide populations

NNB GenCo (SZC) used the PC-CREAM 08 software to assess doses from continuous aqueous discharges and discharges to atmosphere. It used the Atmospheric Dispersion Modelling System (ADMS) to assess doses from short-term releases to atmosphere.

We reviewed NNB GenCo (SZC)'s assessment and concluded that the approach taken was valid and followed appropriate guidance.

We verified its assessment by carrying out our own independent assessment of impact and comparing the outcomes. The outcomes of NNB GenCo (SZC)'s assessment are summarised in Table 7.1:

Table 7.1 Summary of NNB GenCo (SZC)'s assessment outcomes

Assessment	Group/representative person	Annual dose (μSv/y)
Annual dose to the group most exposed to aqueous discharges from Sizewell C	Adult member of a fishing family	10
Annual dose to the group most exposed to discharges to atmosphere from Sizewell C	Infant member of a farming family	6.9
Annual dose to the representative person, considering continuous and short-term discharges and direct radiation from Sizewell C	Adult member of a fishing family	13
Annual dose to the representative person from combined aqueous discharges and discharges to atmosphere from Sizewell B and Sizewell C	Adult member of a fishing family	17
Annual dose to the representative person from historical discharges, future discharges and future direct radiation from Sizewell B and C	Adult member of a fishing family	53

NNB GenCo (SZC)'s assessment predicted that doses would remain well below the source and site dose constraints and the public dose limit.

The dominant exposure pathways were determined to be consuming fish and locally produced cow's milk, with carbon-14 accounting for most of the dose.

NNB GenCo (SZC)'s assessment did not include an assessment of the contribution of current permitted discharges from Sizewell A as it was assumed that by the late 2020s the site would be in a Care and Maintenance (C&M) state, with minimal discharges arising from the site. Recent developments in the Magnox decommissioning strategy for Sizewell A now mean that this strategy may be delayed or changed and so in our own assessment we have accounted for Sizewell A's permitted discharges. We compare our assessment outcomes with the outcomes NNB GenCo provided in section 7.3.

7.1.2. Our assessment – impact on people

Our assessment – permitted discharge quantities (the 'source term')

NNB GenCo (SZC) proposed limits on discharges to atmosphere for tritium, carbon-14, iodine-131, and grouped limits on 'noble gases' and 'other beta emitting radionuclides'. For aqueous discharges, it proposed limits for tritium, carbon-14, cobalt-60, caesium-137 and a grouped limit on 'other radionuclides'. We based the source term for our assessment on the discharge limits NNB GenCo (SZC) requested, together with information provided on the expected breakdown of radionuclides.

The discharge limits NNB GenCo (SZC) requested are based on the discharge limits granted for the new nuclear power station currently under construction at Hinkley Point C. The information provided in the Hinkley Point C permit application was based on information provided in the Generic Design Assessment of the UK EPR^{TM} reactor design. As the proposed reactors at Sizewell C and at Hinkley Point C are of the same design, it is reasonable to use the same typical breakdown of radionuclides within the discharges to carry out an impact assessment. Tables 7.2 and 7.3 show the radionuclides and annual discharges used in our assessment.

Our assessments assumed 60 years of continuous discharges at the proposed permit limits. This allows for the maximum period of any build-up of radionuclides in the environment. This period of operation is reflected in Tables 7.4 to 7.7.

Table 7.2 Atmospheric discharges used in our assessment

Proposed permit – radionuclide or group	Proposed limit (Bq y^{-1})	Radionuclide assessed	Discharges used in the assessment (Bq y^{-1})
Carbon-14	1.40 10^{12}	C-14	1.40 10^{12}
Beta emitting radionuclides associated with particulate matter	1.20 10^{8}	Co-58	3.06 10^{7}
Beta emitting radionuclides associated with particulate matter	1.20 10^{8}	Co-60	3.61 10^{7}
Beta emitting radionuclides associated with particulate matter	1.20 10^{8}	Cs-134	2.81 10^{7}
Beta emitting radionuclides associated with particulate matter	1.20 10^{8}	Cs-137	2.52 10^{7}
H-3	6.00 10^{12}	H-3	6.00 10^{12}
I-131	4.00 10^{8}	I-131	4.00 10^{8}
N/A	N/A	I-133[#]	4.77 10^{8}
Noble gases	4.50 10^{13}	Ar-41	1.31 10^{12}
Noble gases	4.50 10^{13}	Kr-85	6.26 10^{12}
Noble gases	4.50 10^{13}	Xe-131m	1.35 10^{11}
Noble gases	4.50 10^{13}	Xe-133	2.84 10^{13}
Noble gases	4.50 10^{13}	Xe-135	8.92 10^{12}

[#] The assessment allowed for expected discharges of I-133 which represents other isotopes of radioiodine

Table 7.3 Liquid discharges used in our assessment

Radionuclide or group	Proposed limit (Bq y^{-1})	Radionuclide assessed	Discharges used in the assessment (Bq y^{-1})
H-3	$2.00\ 10^{14}$	H-3	$2.00\ 10^{14}$
C-14	$1.90\ 10^{11}$	C-14	$1.90\ 10^{11}$
Co-60	$6.00\ 10^{9}$	Co-60	$6.00\ 10^{9}$
Cs-137	$1.90\ 10^{9}$	Cs-137	$1.90\ 10^{9}$
Other radionuclides	$1.20\ 10^{11}$	Cr-51	$1.18\ 10^{8}$
Other radionuclides	$1.20\ 10^{11}$	Mn-54	$5.31\ 10^{8}$
Other radionuclides	$1.20\ 10^{11}$	Co-58	$4.07\ 10^{9}$
Other radionuclides	$1.20\ 10^{11}$	Ni-63	$1.89\ 10^{9}$
Other radionuclides	$1.20\ 10^{11}$	Ag-110m	$1.12\ 10^{9}$
Other radionuclides	$1.20\ 10^{11}$	Te-123m	$5.11\ 10^{8}$
Other radionuclides	$1.20\ 10^{11}$	Sb-124	$9.63\ 10^{8}$
Other radionuclides	$1.20\ 10^{11}$	Sb-125	$1.60\ 10^{9}$
Other radionuclides	$1.20\ 10^{11}$	I-131	$9.83\ 10^{7}$
Other radionuclides	$1.20\ 10^{11}$	Cs-134	$1.10\ 10^{9}$

Our assessment – doses from continuous discharges to atmosphere and aqueous discharges

We calculated doses from discharges to atmosphere and aqueous discharges at the limits NNB GenCo (SZC) proposed using assessment source terms derived as described. We used our screening tool IRAT (Initial Radiological Assessment Tool) and the PC-CREAM tool together with information on people's habits from local studies.

Members of the public likely to receive the highest doses can be identified by habit surveys. For example, they may consume above average quantities of local foods or spend more time outdoors near to the Sizewell nuclear site. In 2015, the Centre for Environment, Fisheries and Aquaculture Science (Cefas) conducted a habits survey around the Sizewell nuclear site to establish the habits, that is, occupancy rates, consumption rates and activities, of people living nearby (Garrod and others, 2016). This information can be used to form habit profiles which represent different groups of individuals around the site. We considered each of the habit profiles described in the Cefas survey as a candidate for the representative person (CRP), this method is termed 'the habits profiles approach'. In our assessment, we calculated doses to 28 different habits profiles, each of which comprised one or more age groups, that is, adults, children, infants and women of childbearing age (for assessment of doses to the fetus).

To calculate doses for each habits profile, we made assumptions about where each group spent their time and therefore where exposures would occur. We selected locations based on the information about land use and occupancy in the habits survey and locations that would have the highest environmental activity concentrations due to their proximity to the site.

For the assessment of discharges to atmosphere, the production of food for ingestion was assumed to occur at 3 locations:

- local allotments (~2.6km from the site)
- the salt marsh south of Minsmere (~1.3km from the site)
- open access land (~1.3km from the site)

We also assess the impact of exposures to the 'plume'. We use the word plume to describe the flow of the discharge during and after the release to atmosphere. For the assessment of inhalation and external exposures to the discharge 'plume' and deposited radionuclides, members of the public were assumed to spend time at 3 locations:

- the shoreline/beach (~0.5km from the site, plume inner zone)
- local housing (~1.2km from the site, plume middle zone)
- leisure facility (~1.8km from the site, plume outer zone)

For the assessment of aqueous discharges all marine food was assumed to be caught in the sea region adjacent to the Sizewell site. All internal and external exposures to seawater and sediment were also assumed to occur in the sea region adjacent to the Sizewell site.

Doses to groups most exposed to discharges to atmosphere

Table 7.4 provides a summary of doses from discharges to atmosphere for the groups most exposed to discharges to atmosphere from Sizewell C. Our full radiological impact report (Environment Agency, 2022) provides a breakdown of these doses by exposure pathway and radionuclide. The group most exposed to discharges to atmosphere from Sizewell C was determined to be the 'adults spending significant amounts of time at the shoreline/beach location' (termed the 'Adult Plume 0-0.25km' group).

Table 7.4 Annual effective dose (µSv/y) in 60th year for each age group most exposed to discharges to atmosphere from Sizewell C

Age group	Candidate for the representative person	Dose from discharges to atmosphere (µSv/y)
Adult	Plume 0-0.25km	1.40
Child	Plume 0.5-1km	0.084
Infant	Green vegetable consumers	0.083

Doses to groups most exposed to aqueous discharges

Table 7.5 provides a summary of doses from aqueous discharges to the groups most exposed to aqueous discharges from Sizewell C. Our full radiological impact report (Environment Agency, 2022) provides breakdowns of these doses by exposure pathway and radionuclide. The group most exposed to aqueous discharges was found to be an adult sea fish consumer.

Table 7.5 Annual effective dose (µSv/y) in 60th year for each age group most exposed to aqueous discharges from Sizewell C

Age group	Candidate for the representative person	Dose from aqueous discharges (µSv/y)
Adult	Sea fish consumer	3.72
Child	Mollusc consumer	3.69
Infant	Sea fish consumer	3.03

Doses to candidates for the representative person from continuous discharges

Doses were calculated for all 28 habit profiles from both discharges to atmosphere and aqueous discharges to identify those receiving the highest doses from combined discharges. A summary of doses to the candidates for the representative person receiving the highest doses is given in Table 7.6.

The highest annual effective dose from 60 years of operation of Sizewell C was calculated to be 3.8μSv/y for adult sea fish consumers. This group is therefore identified as the representative person for Sizewell C. Our assessment shows most of this dose (92%) comes from the ingestion of carbon-14 in sea fish. For children, the highest dose was 3.7μSv/y for mollusc consumers, with most of the dose (94%) also coming from ingesting carbon-14 in sea fish. For infants, the highest dose was 3.0μSv/y for sea fish consumers and, again, most of the dose (99%) is attributed to ingesting carbon-14 in sea fish.

Doses to the fetus

We also assessed doses to the fetus from Sizewell C discharges using Health Protection Agency (HPA) guidance (HPA, 2008). Of the radionuclides present in the proposed Sizewell C discharges to atmosphere and aqueous discharges, tritium, carbon-14 and iodine-131 require a specific assessment of doses to the fetus.

We performed assessments for ingestion pathways only using the habits profile data reported for women of childbearing age in the Cefas habits report (Garrod and others, 2016). The dose to women of childbearing age was calculated and then scaled using the ratio of the ingestion dose coefficients listed in HPA guidance to obtain the dose to the fetus. For tritium, carbon-14 and iodine-131 the fetal dose coefficients are all higher than the adult dose coefficients, with ratios of 3.5, 1.4 and just over 1.0, respectively.

For the fetus, the highest dose was calculated for women of childbearing age who consumed crustaceans. This profile group had no exposure to releases to atmosphere and exposure is dominated by consumption of seafood. The contributions to the fetal dose from ingesting seafood are carbon-14 (2.9 μSv), tritium (6.3 10^{-3} μSv) and iodine-131 (4.1 10^{-6} μSv). Given the dominance of the carbon-14 ingestion pathway in the total dose for all age groups, the total dose to the fetus will be similar to that of the representative person. The total dose to the fetus will also be bounded by (less than) the estimated total dose to the representative person.

Table 7.6 Annual effective dose (μSv/y) in 60th year to candidates for the representative person from discharges to atmosphere and aqueous discharges from Sizewell C

Age group	Candidate for the representative person	Discharges to atmosphere	Aqueous discharges	Total
Groups receiving highest doses (μSv/y)				
Adult	Sea fish consumers	0.062	3.7	3.8
Child	Mollusc consumers	-	3.7	3.7
Infant	Sea fish consumers	-	3.0	3.0
Groups receiving second highest doses (μSv/y)				
Adult	Crustacean consumers	0.022	3.7	3.7
Child	Sea fish consumers	-	3.0	3.0
Infant	Green vegetable consumers	0.083	-	0.083
Groups receiving third highest doses (μSv/y)				
Adult	Occupancy over saltmarsh	-	3.5	3.5
Child	Occupancy over sediment	0.042	2.2	2.3
Infant	Root vegetable consumers	0.083	-	0.083

Generic assessment of doses in the future

We recognise that by adopting a habits profiles approach, based on recently observed habits, our assessment does not necessarily account for changes in habits and land use over time. To provide insight into other possible exposure pathways, for example to account for additional foods that may be produced locally in the future, we also carried out a more cautious generic assessment of discharges from Sizewell C. Our generic assessment used PC-CREAM 08 with default data and ingestion rates based on national habit survey data rather than using the Sizewell specific occupancy and consumption rates taken from the habits survey.

For the generic assessment, the production of food for ingestion was cautiously assumed to occur 500m to the north of the most northerly discharge stack ('North Stack') and all ingestion pathways in the PC-CREAM 08 model were considered except for grain (as it is not locally grown). To determine the consumption rates of foods, we adopted a top 2 approach, whereby it was assumed that the 2 foods giving the highest doses were consumed at higher-than-average ingestion rates, while other foods were consumed at average rates.

Inhalation and external exposures to the radionuclides discharged to atmosphere (the plume) and the ground were cautiously assumed to occur 250m to the north of the North Stack. It was assumed that individuals spend all their time at this location, 90% of which was indoors.

We also used PC-CREAM 08 for our generic assessment of routine aqueous discharges using default data except for the refined data for the local marine compartment parameters. It was assumed that individuals were exposed to radionuclides in sediments and on fishing gear in the local compartment and consumed seafood at higher than average rates (the 97.5th percentile rate). All molluscs and crustaceans consumed were assumed to be caught in the local compartment. For sea fish, it was assumed that 10% of the catch was taken from the local compartment and the remainder from the regional compartment.

A summary of the annual effective doses calculated using our generic approach is presented in Table 7.6.

Table 7.6 Annual dose (µSv/y) from 60 years of routine discharges from Sizewell C to a member of the public based on a conservative generic dose assessment

Age	Discharges to atmosphere (µSv/y)	Aqueous discharges (µSv/y)	Total (µSv/y)
Adult	9.1	8.7	18
Child	9.9	3.6	14
Infant	17	1.3	18

Using the conservative potential future habits data, the total annual dose from routine discharges from Sizewell C to an adult living near the site, was calculated to be almost 5 times greater than the dose calculated using the more realistic habits profile (18μS/yr compared to 3.8μS/yr (see Table 7.5)). The main reason for this is that the potential future habits data includes consumption of local cow's milk. The Sizewell habits survey does not show any consumption of locally (within 5km) produced milk, therefore ingestion of cow's milk and cow's milk products was not included in our main assessment using site-specific habits.

For aqueous discharges, the doses calculated in our assessment of potential future habits were similar to those calculated using the habits profile method. This is because in both methods, the main contribution to the dose comes from ingesting carbon-14 in seafood, and both assessments use the same environmental activity concentrations in the local marine compartment.

Our assessment – doses from direct radiation

Our calculation of doses to members of the public exposed to direct radiation from the Sizewell C site followed a similar approach to that described in NNB GenCo (SZC)'s assessment. NNB GenCo (SZC)'s assessment recognised that the design of interim spent fuel and intermediate level waste storage facilities are yet to be finalised and specific details on shielding and inventories of the building are not yet available. In our assessment, we assumed that doses from exposure to the reactor building will be negligible because of the high level of shielding. Therefore, the majority of the direct radiation dose will come from the interim spent fuel and intermediate level waste storage facilities on site. We assumed that the outside of any building is an undesignated area and is therefore subject to the annual dose limit of one mSv/y for non-radiation workers under Ionising Radiations Regulations 2017 (IRR17) (UK Parliament, 2017a). We then extrapolated this dose rate to receptor locations of interest to calculate the dose from direct shine. We also considered the impact of sky shine. Sky shine is indirect external exposure to radiation emitted from the source and then scattered from the atmosphere back to the ground. We assumed the impact of sky shine is comparable to the impact from direct shine so the total dose from direct radiation dose is assumed to be double that of direct shine.

NNB GenCo (SZC)'s assessment identified 3 possible groups most exposed to direct radiation. These are people who spend time walking the footpaths around the north and east side of the proposed development (such as a dog walker), a resident in a nearby property and a worker on the Sizewell B site. We considered these groups as well as some of the habits profiles from the Sizewell habit survey (Garrod and others, 2016). We assessed 3 habits profiles that represent those individuals most exposed to direct radiation as well as the habit profile of the representative person identified from our assessment of aqueous discharges and discharges to atmosphere (adult sea fish consumer).

Annual doses from direct radiation to the groups assessed are shown in Table 7.8. The highest annual effective dose from direct shine was 3.7μSv/y for a Sizewell B worker, so the highest annual effective dose from direct radiation, including sky shine was calculated as 7.4μSv/y. This value is comparable to the direct radiation doses received by Sizewell A workers from the Sizewell B site reported in the most recent RIFE reports for 2019 and 2020, 9μSv/y and 16μSv/y respectively. The projected direct radiation doses to members of the public are very small.

During our permit determination, NNB GenCo (SZC) proposed some minor changes to the location of the interim spent fuel store and intermediate level waste store buildings from the site plan provided in the application. It provided us with an assessment of the impact of this change on direct doses to members of the public. The assessment NNB GenCo (SZC) carried out estimated the change to slightly increase the annual direct radiation dose to the most affected group by less than 0.001microsievert. We reviewed the assessment NNB GenCo (SZC) completed and considered the impacts on direct dose from these changes to be negligible. We did not therefore look to revise our independent assessment to account for this minor change.

Our assessment – doses from short duration discharges to atmosphere

We also assessed the impact of short-term discharges to atmosphere that are expected as part of the normal operation of Sizewell C. Such discharges may occur during reactor start-up or shutdown and lead to larger than average releases over relatively short periods of time. These discharges must not exceed the permitted limits but may occur in conjunction with other factors, such as poor dispersion conditions, and may lead to short duration enhanced doses to the public.

We assessed the doses from short duration discharges to 7 habits profile groups. The habits profile groups included:

- the candidates for the representative person identified as receiving the highest total dose from continuous releases (‘adult sea fish consumers’, ‘child mollusc consumers’ and ‘infant sea fish consumers’)
- the group identified as most exposed to continuous discharges to atmosphere (‘adult plume 0 to 0.25km’)
- 3 groups for which generic habit data were used. The habits of these groups were the same as those described in the generic assessment carried out for continuous releases

PC-CREAM 08 is not designed to assess doses from short-term releases, therefore the Atmospheric Dispersion Modelling System (ADMS 4.2) (CERC, 2010) was used with guidance provided by the National Dose Assessment Working Group (NDAWG) (NDAWG, 2020) and the methodology described in NRPB W54 (Smith and others, 2004). We assessed annual effective doses from exposures arising in a 12-month period following a short-term release to atmosphere. We used the source term NNB GenCo (SZC) provided to make our assessment and assumed a release duration of 12 hours as recommended in the guidance NDAWG provided. We calculated doses from the following exposure pathways:

- inhalation of, and external exposure to, radionuclides in the plume

- external exposure to gamma radiation from radionuclides deposited on the ground
- ingestion of radionuclides in terrestrial foods
- inhalation of radionuclides re-suspended into the air

Table 7.8 Annual doses (μSv) from direct radiation

Candidates for the representative person	Annual direct radiation dose (μSv/y)	Annual direct radiation dose (μSv/y)	Annual direct radiation dose (μSv/y)
	Interim spent fuel store	Intermediate level waste store	Total
Dog walker	-	0.96	0.96
Resident	0.0017	0.0017	0.0034
Sizewell B worker	7.4	0.0048	7.4
Adult Plume (IN: 0-0.25km)	2.2	0.0046	2.2
Adult Plume (MID: >0.25-0.5 km)	0.0011	0.00076	0.0018
Adult Plume (OUT: >0.5-1 km)	0.00046	0.00036	0.00082
Adult sea fish consumer (Representative person)	0.32	0.00078	0.32

Doses were calculated to individuals living at and obtaining food from a location 500m from the discharge point in the direction of the prevailing wind.

To support our decision on whether to set any weekly advisory limits (WALs) we also assessed the impact should the maximum proposed annual limits be discharged over the same short period of 12 hours. We discuss WALs in Chapter 6.

Annual doses from short-term discharges from Sizewell C to the groups we assessed are summarised in Table 7.9.

Using NNB GenCo (SZC)'s predicted short-term discharge scenario, the highest annual dose from short-term releases of discharges to atmosphere was calculated to be 3.5μSv to an adult with a generic habit profile. For doses to the candidates for the representative person assessed, more than 60% of the dose comes from directly inhaling carbon-14 in the dispersing plume. In the case of the generic habits profiles assessed, most of the dose (>80%) comes from ingesting carbon-14 in food.

Table 7.9 Annual effective doses from a short-term release to atmosphere from Sizewell C based on NNB GenCo (SZC) predicted short-term discharges and from a short-term discharge at the proposed annual limit

Age group	Habit profile	Annual effective dose (µSv/y) based on NNB GenCo (SZC) predicted short-term discharges	Annual effective dose (µSv/y) based on a short-term discharge at the proposed annual limit
Candidates for the representative person			
Adult	Sea fish consumer	0.59	7.1
Child	Mollusc consumer	0.46	5.5
Infant	Sea fish consumer	0.38	4.5
Group most exposed to continuous discharges to atmosphere			
Adult	Plume IN 0-0.25km	0.57	6.8
Generic habits profiles			
Adult	Generic ingestion rates	3.5	82
Child	Generic ingestion rates	2.9	91
Infant	Generic ingestion rates	1.9	170

Our assessment showed that even if the entire annual limit was to be discharged in a short period of 12 hours, the doses would remain less than the source constraint (300µSv/y).

We also compared the activity concentrations in food following a short-term release of the entire annual limits with the maximum permitted limits (MPLs) set out in Euratom Regulation 2016/52 (which is retained EU law). We found activity concentrations in foodstuffs calculated to be well below the relevant MPLs. This assessment is described further in our full report on our radiological impact assessment (Environment Agency, 2022).

There is no requirement to assess the impact of short-term aqueous discharges to the marine environment, as significant short-term aqueous discharges under normal operation are unlikely to occur. Aqueous wastes suitable for discharge are to be held in storage tanks before release and follow a semi-continuous release process. The NDAWG guidance notes that the considerable dilution effects of tides and currents in the marine environment mean the impact in the unlikely event of significantly elevated short-term aqueous releases is not likely to be significant.

Our assessment – doses to the representative person

Our assessment of doses from routine discharges to atmosphere and aqueous discharges from the Sizewell C site identified the representative person as a member of the ‘adult sea fish consumers’ group.

Our assessment of the representative person, including doses from direct radiation and short-term releases, was calculated to be 4.7µSv/y. This comprised 79% from aqueous discharges, 13% from short-term discharges to atmosphere, 7% from direct radiation and less than 1% from continuous discharges to the atmosphere (see Table 7.10).

As part of our assessment of total dose to the representative person, we also take into consideration other sources of radiation that the representative person might be exposed to. Our assessment of total dose therefore also considers all proposed future discharges and historic discharges to the atmosphere and to the sea from Sizewell A and Sizewell B.

Doses arising from future discharges from Sizewell A and Sizewell B were calculated using the same approach as described for Sizewell C. The same habits profiles were used, but source terms relevant to the A station and B station at Sizewell were used, taking into account their permit limits and, for the discharges to atmosphere, the different positions of the discharge stacks.

The outcomes of our assessments of total dose are summarised in Tables 7.10 and 7.11.

Doses from historical discharges from Sizewell A and Sizewell B were assessed as 19µSv/y by taking the average of the dose to the representative person calculated in RIFE-23, RIFE-24 and RIFE-25 (Environment Agency and others, 2018a, 2019 and 2020). The doses presented in the RIFE reports are based largely on measurements of environmental radioactivity taken around the site.

We calculated the total dose to the representative person received in the 60th year, assuming discharges at all 3 stations continue at current or proposed permitted levels, to be 28µSv/y. Contributions to the dose are historical discharges from Sizewell A and Sizewell B (68%), future operation of Sizewell C (17%), decommissioning of Sizewell A (14%) and future operation of Sizewell B (2%).

Table 7.10 Annual effective dose (µSv/y) to the representative person (adult sea fish consumer) from the Sizewell site after 60 years of operation (no historical contribution)

Source	Discharges to atmosphere	Aqueous discharges to sea	Direct	Short-term discharge to atmosphere	Total
Sizewell C	0.062	3.7	0.32	0.59	4.7
Sizewell B	0.071	0.52	-	-	0.59
Sizewell A	0.013	4.0	-	-	4.0
Total	-	-	-	-	9.3

Table 7.11 Annual effective dose (µSv/y) to the representative person at the Sizewell site after 60 years of operation, including historical discharges and direct radiation from Sizewell A and Sizewell B

Source	Total (µSv/y)
Future discharges 60th year Sizewell A+ Sizewell B+ Sizewell C	9.3
Sizewell A + Sizewell B historical discharges and direct radiation*	19
Total (future and historic discharges)	28

* Historic total doses taken from RIFE-23, RIFE-24 and RIFE-25 (Environment Agency and others, 2018a, 2019 and 2020)

As Sizewell A is expected to have entered care and maintenance by the time Sizewell C is operational, it is not realistic to assume that discharges will continue at the current permitted limits until the 60th year of operation at Sizewell C (around 2090). To account for this, we made a further assessment using the current actual discharges from Sizewell A taken from RIFE-24, rather than the permit limits, as a more realistic prediction of future discharges. When the current discharges from Sizewell A are used in the assessment, rather than the permitted limits, the total dose to the representative person from future and historical discharges decreases from 28µSv/y to 25µSv/y.

Our assessment – collective doses

Collective dose may be used to provide an estimate of the total radiological impact on a population. It is most useful when comparing different process or disposal options. Collective dose is the sum of all the doses received by the members of a specified population over a specified period of time. The unit of collective dose rate is person-Sieverts per year of discharge (person-Sv/y).

There are no limits or constraints for collective dose. However, the UK Health Protection Agency (now part of the UK Health Security Agency) has advised, in relation to permitting discharges, calculating an average dose to members of the population (per person or per caput dose). Average doses can be calculated from the collective dose divided by the number of people in the specified population to give average per person doses. If the average dose is in the nanosievert per year (nSv/y) range or below, the collective dose does not need to be considered further in the decision-making process (HPA, 2009).

We have calculated collective doses and per caput doses. We did this for the UK, European and world populations, for up to (truncated at) 500 years, assuming one year of discharges made at the proposed annual permit limits (for aqueous discharges and discharges to atmosphere). We used the PC-CREAM 08 software to estimate collective dose. Our results are set out in Table 7.12 below.

Table 7.12 Collective doses truncated at 500 years for Sizewell C atmospheric and liquid discharges

Population	Collective dose (person-Sv per year of discharge) Discharges to atmosphere	Collective dose (person-Sv per year of discharge) Liquid discharges	Per caput doses (nSv per person per year of discharge) Discharges to atmosphere	Per caput doses (nSv per person per year of discharge) Liquid discharges
UK	0.43	0.035	7.6	0.59
Europe	3.6	0.21	7.9	0.58
World	27	2.3	2.7	0.23

For comparison, the annual collective dose to the UK population from natural background radiation has been calculated as 140,000person-Sv (PHE, 2016).

As the per-caput doses are in the nSv/y range, we consider that the proposals to minimise discharges do not require any additional measures to reduce collective doses.

7.1.3. Foods Standards Agency assessment – impact on people

As part of the public consultation process, the FSA provided an opinion on the risk to the public via the food chain. The FSA carried out a full dose assessment, including doses from non-food chain pathways, to provide greater context to their estimated dose. The FSA assessed the dose to candidates for the representative person. FSA constructed habits profiles for each candidate for the representative person using data from the Sizewell habits survey (Garrod and others, 2016) combined with default food consumption rates (Byrom and others, 1995) where no data were recorded in the habits survey. This means that the FSA accounted for the consumption of some products which are not recorded as being produced in the survey area. Consumption and occupancy rates for each candidate for the representative person were determined using a high-rate consumption or occupancy for the dominant pathway and the mean rates for the remaining pathways. For example, the crustacean consumer profile used crustacean consumption at the 97.5th percentile rate and all other consumption and occupancy rates at the mean rate.

FSA calculated doses to the representative person using ADMS 5 version 5.2.0 for modelling the dispersion of atmospheric discharges and their own internal assessment tools, PRISM version 3.8.0 for modelling the incorporation of the atmospheric radionuclides into terrestrial foodstuffs and PRAME version 4.5.2250 for modelling marine food pathway exposures. The outcomes from these models were then combined in a dose conversion and/or whole dose assessment spreadsheet to calculate an annual dose.

FSA identified the representative person as an infant from the fishing family who is a high consumer of milk with an estimated dose of 24μSv/y from all pathways. The predominant exposure pathway was milk which contributed 11μSv/y and the predominant radionuclide was carbon-14 contributing 16μSv/y of the calculated dose. It is worth noting that the FSA's assessment accounted for the consumption of locally produced milk even though there is currently no cow's milk produced in the survey area. We compare our assessment outcomes with the outcomes provided by the FSA in section 7.3.

7.2. Radiological assessment: impact on wildlife

In this section, we have considered the radiological impact of the discharges on wildlife.

The Sizewell nuclear site is surrounded by a diverse range of wildlife habitats and species. Many of these habitats are designated as protected sites under local, national and international law. The significant diversity of habitats and wildlife species means that it is not possible to calculate dose rates to all species. Radiological impact assessments for wildlife are carried out using data sets which have been compiled for some main organisms chosen to be representative of the large diversity of wildlife species. These data sets are available from ICRP for Reference Animals and Plants (RAPs) (ICRP, 2008) and from the Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) tool (Brown et al, 2016) for reference organisms. Current guidance, (ICRP, 2008) and (IAEA, 2018), recommends that the impact of ionising radiation on wildlife and their habitats can be assessed by calculating dose rates to the RAPs or reference organisms.

At the Environment Agency, we currently use the reference organisms in the ERICA tool. If the dose rate to the most exposed reference organism is below the relevant threshold, and it can be demonstrated that the reference organisms are an adequate representation of the wildlife requiring protection, then it is reasonable to assume that the integrity of the habitat, and the wildlife that occupy it, will be unaffected. The European research project, 'Framework for assessment of environmental impact' (FASSET) concluded that the threshold for statistically significant effects on organisms is about 100 microgray per hour (µGy/h). Allowing for the dose rate from natural background, which is at most about 60µGy/h, we have adopted a value of 40µGy/h as the level below which we and Natural England consider there will be no adverse effect on wildlife species.

When making an initial assessment of the dose rates from a single site we use simplified assumptions and a dose rate screening criterion of one µGy/h for wildlife. We consider this value sufficiently cautious that we would not expect wildlife and their habitats to be adversely affected by radiation exposure at or below this level. Should this screening criterion be exceeded, we would then use site-specific data and more detailed modelling to generate more realistic assessments.

7.2.1. NNB GenCo (SZC)'s assessment – impact on wildlife

NNB GenCo (SZC) included an assessment of the impact of the discharges on wildlife in its application.

NNB GenCo (SZC)'s assessment used outputs from the PC-CREAM 08 model (as used for the human impact assessment), the ERICA tool (Brown and others, 2016) and the 'Ar-Kr-Xe dose calculator' for noble gas exposure (Vives I Batlle and others, 2015), together with information on local wildlife and protected habitats.

NNB GenCo (SZC)'s assessment considered 5 different habitat types to represent the main ecological receptors in the vicinity of the proposed Sizewell C site.

NNB GenCo (SZC)'s assessment showed that the dose rate to the most affected reference organism from Sizewell C discharges to be 0.8µGy/h. The most affected reference organism was found to be polychaete worm occupying a marine habitat. NNB GenCo (SZC) also assessed the impact of combined discharges from Sizewell B and Sizewell C. This assessment showed the most affected reference organism to be insect larvae occupying a freshwater habitat with a dose rate of 2.7µGy/h.

We reviewed NNB GenCo (SZC)'s assessment and concluded that the approach taken was valid and followed appropriate guidance. We also verified the outcomes presented by performing our own assessment using the information provided in the application. We were able to reproduce the outcomes NNB GenCo (SZC) presented and therefore consider its assessment to be satisfactory.

7.2.2. Our assessment – impact on wildlife

We also considered the potential impact of discharges of radioactive waste from the Sizewell C site on wildlife at relevant protected sites (special protection areas (SPAs) for birds, and special areas of conservation (SACs) for other species and for habitats) designated under the Conservation of Habitats and Species Regulations 2017 (National Site Network sites), relevant Marine Conservation Zones (MCZs) designated under the Marine and Coastal Access Act 2009 and Sites of Special Scientific Interest (SSSI).

Our assessment – source term

The source term for our assessment of the impact on wildlife from Sizewell C discharges is the same as that used in our assessment of the impact on people (see Tables 7.2 and 7.3).

PC-CREAM 08 was used to calculate environmental activity concentrations following 60 years of operation of the reactors at Sizewell C. For discharges to atmosphere, PC-CREAM 08 was used to calculate activity concentrations in air and soil at the relevant receptor locations using the same parameters and methodology applied for our human radiological impact assessment. For discharges to sea, PC-CREAM 08 was used to calculate activity concentrations in the Sizewell local marine compartment.

Our assessments of dose rates to wildlife have been made assuming discharges are made at the annual limits NNB GenCo (SZC) proposed. The values used for the terrestrial assessment were the proposed limits for discharges to air. Those used for the marine assessment were the proposed limits for discharges to the marine environment.

There are no direct discharges to freshwater from the Sizewell C site. However, radionuclides could enter the freshwater environment as a result of deposition following discharges to air. We used the approach described in IAEA report SRS 19 (IAEA, 2001) to predict the concentrations of radionuclides present in the freshwater environment following discharges to air.

Our assessment considers the impact of Sizewell C discharges alone and in combination with the current permitted discharges from Sizewell A and Sizewell B.

Our assessment – dose rates to most affected reference organisms

We assessed the dose rate to wildlife inhabiting locations within 3 protected sites:

- Minsmere-Walberswick Heaths and Marshes SSSI, SPA, SAC and Ramsar site
- Sizewell Marshes SSSI
- Outer Thames Estuary SPA

We selected these sites as they represent those which would be most affected by the discharges due to their proximity to the Sizewell C site.

We used the ERICA tool (Brown and others, 2016), together with the ‘Ar-Kr-Xe dose calculator’ (Vives I Batlle and others, 2015) in combination with outputs from the PC-CREAM 08 model to carry out assessments of the impact on reference organisms located in the 3 protected sites we selected.

To assess the impact on terrestrial wildlife at Minsmere and Sizewell Marshes, we selected locations in the middle of each site and at the point closest to the Sizewell C site. We did this to determine the range of possible dose.

Minsmere and Sizewell Marshes both have scrapes which are shallow depressions with gently sloping edges which seasonally hold water. Dose rates to freshwater biota at these sites were only calculated for the central point of the scrape area because these water bodies receive run-off from a large area and it would not be representative to calculate dose rates based only on activity concentrations at the closest point to the Sizewell C site.

The marine wildlife assessed were assumed to be located in the local Sizewell compartment of the DORIS model in PC-CREAM 08 which we have used to represent the Outer Thames Estuary SPA.

The closest Marine Conservation Zone to the Sizewell site is the Orford Inshore zone which is located ~17km offshore. The environmental activity concentrations in the Orford Inshore would be lower than those in the local Sizewell marine compartment which we used in our assessment. Therefore, we did not carry out a specific assessment of the Orford Inshore as the impact on marine wildlife further offshore would be lower.

We assessed the dose rates to a range of reference organisms that are representative of species found at the protected sites of interest. Our assessment of radiological impacts report (Environment Agency, 2022) provides a full description of the reference organisms considered and how these are representative of species inhabiting the protected sites assessed.

We assessed dose rates (µGy/h) to wildlife in the terrestrial environment for locations in Minsmere-Walberswick Heaths and Sizewell Marshes. The dose rates to the most affected terrestrial reference organisms are summarised in Table 7.13.

We assessed dose rates (µGy/h) to wildlife in the freshwater environment for locations in Minsmere-Walberswick Heaths and Sizewell Marshes. The dose rates to the most affected freshwater reference organisms are summarised in Table 7.14.

We assessed dose rates (µGy/h) to wildlife in the marine environment within the Outer Thames Estuary. The dose rates to the most affected reference organisms are summarised in Table 7.15.

Table 7.13 Dose rates to reference organisms in terrestrial environment from Sizewell C discharges

Location	Reference organism receiving highest dose rate	Dose rate Sizewell C (µGy/h)
Minsmere-Walberswick Heaths **(Location nearest to Sizewell C)**	Mammal – small burrowing, Mammal – large	$4.6\ 10^{-3}$
Minsmere-Walberswick Heaths **(East and west Scrape)**	Mammal – small burrowing, Mammal – large, Reptile	$2.5\ 10^{-4}$
Sizewell Marshes **(Location nearest to Sizewell C)**	Mammal – small burrowing, Mammal – large	$2.3\ 10^{-3}$
Sizewell Marshes **(Sizewell marshes mid-point of region)**	Mammal – small burrowing, Mammal – large	$9.9\ 10^{-4}$

Table 7.14 Dose rates to reference organisms in freshwater environment from Sizewell C discharges

Location	Reference organism receiving highest dose rate	Dose rate (µGy/h)
Minsmere-Walberswick Heaths **(East and West Scrape)**	Insect Larvae	$9.4\ 10^{-2}$
Sizewell Marshes **(Sizewell marshes mid-point of region)**	Insect Larvae	$2.3\ 10^{-1}$

Table 7.15 Dose rates to reference organisms in marine environment from Sizewell C discharges

Location	Reference organism receiving highest dose rate	Dose rate (µGy/h)
Outer Thames Estuary	Polychaete worm	$6.0\ 10^{-2}$

The reference organism receiving the highest dose rate was found to be insect larvae occupying a freshwater environment within the Sizewell Marshes. The dose rate to the most affected reference organism was calculated to be 0.23µGy/h, which is far lower than our 40µGy/h threshold, below which we consider there will be no adverse effect on wildlife. We therefore consider that the proposed discharges of radioactive wastes into the environment at the proposed limits from the Sizewell C site, taken alone, would not adversely affect wildlife.

The dose rates calculated represent the exposure of the reference organism to a single environment. Exposures from more than one environment have not been added together as it has been assumed that each reference organism remains in a single environment. This approach will capture the worst-case scenario where a reference organism remains exposed to the area of highest local contamination all of the time.

Our assessment – impact on protected sites

We have also assessed the potential impact at the relevant designated protected sites and Marine Conservation Zones (MCZ), of the discharges of radioactive wastes into the environment from the Sizewell C site, in-combination with those from other relevant premises holding environmental permits authorising radioactive discharges. We made this assessment using our review of habitats assessments for radioactive substances conducted in 2017 (Allott and others, 2019). The 2017 habitats report assessed the impact of all permitted discharges on National Site Network sites in England and, in each case, reported the total dose rate to the most affected reference organism. The total dose rate was derived by summing the highest aquatic (marine or freshwater) and highest terrestrial dose rates for the most affected reference organisms in each environment.

We assessed the total dose rate to the most affected reference organism at each of the protected sites considered in our assessment by combining the total dose rates to the most affected reference organism calculated in the habitats report with the dose rates to the most affected organism predicted for Sizewell C discharges. The locations assessed and results are summarised in Table 7.16.

Table 7.16 Absorbed dose rates (µGy/h) to most affected reference organism at each wildlife site

Location/ most affected reference organism	Dose rate from Sizewell C proposed discharges	Dose rate from existing discharges (habitats report, Allott and others, 2019)	Total dose rate
Sizewell Marshes **freshwater insect larvae**	0.23	0.81	1.0
Minsmere to Walberswick Heaths and Marshes **freshwater insect larvae**	0.094	0.81	0.9
Outer Thames Estuary **polychaete worm**	0.06	1.8	1.9

The habitats report only considers National Site Network sites so an assessment of the dose rate from existing discharges is not available for Sizewell Marshes. The dose rate for Minsmere to Walberswick Heaths and Marshes was used to represent the likely dose rate to the most affected organism at Sizewell Marshes from existing discharges. This is an approximation but should give a reasonable assessment of the impact on this habitat.

The predicted dose rates at the protected sites assessed, from the combined radioactive discharges, are all below our threshold value of 40µGy/h, below which we and Natural England consider that there will be no adverse effects on the integrity of National Site Network sites. We therefore consider that the discharges of radioactive wastes into the environment at NNB GenCo (SZC)'s proposed limits, together with other authorised discharges of radioactive waste, would not:

- adversely affect the integrity of the National Site Network sites
- significantly affect the protected features of, or hinder the achievement of the conservation objectives for, the MCZ

In our assessment, we selected protected sites which would represent those which would be most affected due to their proximity to the Sizewell C site. When considering our conservation duties, we can infer that, because the dose rate to the reference organisms at the locations we assessed is below 40µGy/h, there will be no effect on wildlife at the population level from the radioactive discharges from Sizewell C.

Our conservation duties

We have considered our various conservation duties listed below.

Section 6(1)(a)(b) and (c) of the Environment Act 1995 We must, to such extent as we consider desirable, generally promote:

- the conservation and enhancement of the natural beauty and amenity of inland and coastal waters and of land associated with such waters
- the conservation of flora and fauna which are dependent on an aquatic environment

Section 7(1)(b) of the Environment Act 1995 We must have regard to the desirability of conserving flora, fauna and geological or physiographical features of special interest.

Section 7(1)(c)(ii) of the Environment Act 1995 We must take account of the effect any proposal would have on any flora, fauna, features or sites.

Section 8(3) of the Environment Act 1995 We take account of any notification and/or consultation responses received under section 8(3) of EA 95 (relating to sites of special interest and national parks).

Section 9 of the Environment Act 1995 In discharging our duties under section 6(1), 7 or 8 of EA 95, we must have regard to any code of practice approved under section 9.

The Conservation of Habitats and Species Regulations 2017 Before deciding to give a permit which:

(a) is likely to have significant effect on a European site or a European offshore marine site (either alone or in combinations with other plans or projects), and

(b) is not directly connected with or necessary to the management of that site

we must make an appropriate assessment of the implications for that site in view of that site's conservation objectives. We must consult Natural England if there is a significant effect.

Section 11 of the Countryside Act 1968 In exercising our functions we must have regard to the desirability of conserving the natural beauty and amenity of the countryside.

Section 28G of the Wildlife and Countryside Act 1981 We must take reasonable steps, consistent with the proper exercise of our functions, to further the conservation and enhancement of the flora, fauna, or geological or physiographical features, by reason of which a site of special scientific interest (SSSI) is of special interest.

Section 28I of the Wildlife and Countryside Act 1981 We must consult Natural England before permitting any operation which is likely to damage any flora, fauna or geological or physiographical features by reason of which a SSSI is of special interest.

Section 85 of the Countryside and Rights of Way Act 2000 In exercising or performing any functions in relation to, or so as to affect, land in an area of outstanding natural beauty

(AONB), we must have regard to the purpose of conserving and enhancing the natural beauty of the AONB.

Section 11A of the National Parks and Access to the Countryside Act 1949 In exercising or performing any functions in relation to, or so as to affect, land in a National Park, we must have regard to the purposes of conserving and enhancing the natural beauty, wildlife and cultural heritage of the national park and of promoting opportunities for the understanding and enjoyment of its special qualities by the public.

Section 40 of the Natural Environment and Rural Communities Act 2006 We must have regard to the purpose of conserving biodiversity when deciding whether to grant an authorisation (and what conditions to impose). Conserving biodiversity includes, in relation to a living organism or type of habitat, restoring or enhancing a population or habitat.

Sections 58, 125 and 126 of the Marine and Coastal Access Act 2009 Any authorisation decision we take must be in accordance with the appropriate marine policy document, unless relevant considerations indicate otherwise. Where capable of affecting (other than insignificantly) the protected features (or supporting processes) of a Marine Conservation Zone (MCZ), we must exercise our functions in a manner which we consider best furthers the conservation objectives stated for that MCZ, or, where this is not possible, in a manner which least hinders the achievement of those objectives. We must be satisfied that there is no significant risk of hindering the achievement of the conservation objectives stated for the MCZ.

Regulation 9 of the Marine Strategy Regulations 2010 We must have regard to the marine strategy (in so far as it has been developed and published to date).

In selecting the locations at which to carry out our assessment, we selected protected sites which would represent those which would be most affected due to their proximity to the Sizewell C site. When considering our conservation duties, we can infer that, because the dose rate to the reference organisms at the locations we assessed is below 40μGy/h, there will be no effect on wildlife at the population level from the radioactive discharges from Sizewell C and the integrity of the habitat sites will be unaffected.

As there can be no effect of radiation on purely physical features such as the geology, physiographical features or the built environment, we do not assess the effects of ionising radiation on non-living materials.

We assessed the application in accordance with our guidance and concluded that for the purposes of the Habitats Regulations there was the potential for significant effects on European Sites and carried out an Appropriate Assessment (Habitats Regulations Assessment Stage 2) of those effects. We have made this available as part of our consultation on our proposed decision. We consulted Natural England on the Appropriate Assessment, and it agreed with our conclusion, that the proposed discharges of radioactive waste would not have adverse effects on the interest features of National Site Network sites.

In view of our assessment of the Outer Thames SPA, represented by the Sizewell local marine compartment, we consider that our proposed decision on this permit is in accordance with the South East Inshore Marine Plan. We have also had regard to the UK Marine Strategy and consider there is nothing in it which would lead us to any different conclusions from those we have already reached through our assessment of impact on wildlife in the marine environment.

We are therefore satisfied that we have addressed our conservation duties in coming to this proposed decision and that no additional or different requirements need to be included in the draft permit in order to satisfy them.

7.3. Summary and comparisons of assessment outcomes

Tables 7.17 to 7.20 summarise the outcomes of our assessments and NNB GenCo (SZC)'s assessments for ease of comparison.

Table 7.17 Annual dose to representative person from Sizewell C

Assessment	Representative person	Annual dose to representative person from proposed Sizewell C discharges
NNB GenCo (SZC)'s assessment	Adult member of fishing family	13μSv/y
Our assessment	Adult sea fish consumers	4.7μSv/y
FSA assessment	Infant member of fishing family	24μSv/y

The terminology used to describe the representative person is different in each organisation's assessments. Whilst the habits used by each organisation do differ, a member of the fishing family and a sea fish consumer can be considered comparable, in other words, in all 3 assessments the representative person is a high consumer of fish.

Table 7.18 Annual dose to the representative person from the combined Sizewell site

Assessment	Representative person	Annual dose to the representative person from the site (combined Sizewell A, B, C)
NNB GenCo (SZC)'s assessment	Adult member of fishing family	17μSv/y
Our assessment	Adult sea fish consumers	9.3μSv/y

Table 7.19 Annual dose to representative person including historical and future discharges

Assessment	Representative person	Annual dose to representative person including historical and future discharges
NNB GenCo (SZC)'s assessment	Adult member of fishing family	53μSv/y
Our assessment	Adult sea fish consumers	28μSv/y

Table 7.20 Dose rate to most affected reference organisms

Assessment	Most affected reference organism and habitat	Dose rate
NNB GenCo (SZC)'s assessment	Polychaete worm (marine habitat)	0.80μGy/h
Our assessment	Insect larvae (freshwater habitat)	0.23μGy/h

All 3 assessments used similar methodologies and produced outcomes which are of the same order of magnitude. In all 3 assessments, the impact on people was found to be dominated by exposure to carbon-14 by consuming seafood and locally produced cow's milk. Both the FSA and NNB GenCo (SZC)'s assessments were more conservative than our assessment. The main differences between the assessments, which account for the variations in results, can be summarised as follows:

- both the FSA and NNB GenCo (SZC) included exposure via ingestion of locally produced cow's milk in their assessments. We did not include this exposure pathway as cow's milk is not currently produced in the Sizewell area
- the receptor locations used in each assessment were different. Our assessment used receptor locations which were further away from the proposed Sizewell C site than those used by NNB GenCo (SZC) and the FSA
- we included permitted discharges from Sizewell A in our assessment of the impact from the Sizewell site as a whole. NNB GenCo (SZC) did not include the discharges from Sizewell A in its assessment

Comparison of doses with the source constraint

EPR 2016 specifies a dose constraint of 300μSv/y for the maximum dose to people due to discharges from a single new source. While this constraint applies specifically to 'new' sources, we generally also apply it to existing sources. For this case, the source is defined as a single power station with 2 reactor units. The dose to be compared to this constraint should include the dose from current or proposed discharges and direct radiation but exclude the dose from historical discharges and from any adjacent site.

Our assessment found the sum of doses from discharges and direct radiation to the representative person from the discharges from Sizewell C to be 4.7μSv/y which is less than the source dose constraint (less than 2% of the constraint).

The NNB GenCo (SZC) assessment found this to be 13μSv/y and FSA found this to be 24μSv/y, both of which are also less than the source dose constraint.

Comparison of doses with the site dose constraint

EPR 2016 also specifies a site dose constraint of 500μSv/y for the maximum dose to people due to discharges from a site as a whole. The dose to be compared to this constraint is the dose from current discharges, including discharges made by adjacent sites. Doses arising from direct radiation and from historical discharges are excluded.

Taking into account all the discharges from Sizewell C, including those from the adjacent A and B stations, our assessment found the dose to be 9.3μSv/y which is less than the site dose constraint (less than 2% of the constraint).

NNB GenCo (SZC) considered discharges from Sizewell B and C in its assessment of site discharges and found the dose to the representative person from the Sizewell site to be 17μSv/y which is also less than the site dose constraint.

Comparison with the dose limit for members of the public

EPR 2016 requires that permit holders ensure that doses to members of the public from exposure to ionising radiation does not exceed 1,000μSv/y. The total dose to members of the public (representative person) near the site takes into account doses arising from:

- future discharges
- future direct radiation from the site
- future discharges from other nuclear sites in the vicinity of the site
- direct radiation from other nuclear sites in the vicinity of the site
- the residue of radioactivity in the environment from past discharges

We calculated that the total dose to the representative person from all the sources listed above to be 28μSv/y. NNB GenCo (SZC)'s assessment found this to be 53μSv/y. Both of these figures are below the dose limit for members of the public of 1,000 μSv/y (less than 6% of the dose limit).

7.4. Conclusions

Overall, subject to our consideration of issues which may arise during consultation, we consider that:

- the doses to the public from the proposed discharges from the Sizewell C site would be below the dose criteria specified in Schedule 23 part 4 section 1 of EPR 2016
- the total doses from the proposed discharges, direct radiation, future short-term discharges and from past discharges from the Sizewell site as a whole are well below the dose limit for the public
- the dose rates to wildlife from the proposed discharges from the Sizewell site will be below the threshold at which the Environment Agency and Natural England have agreed there would be no adverse effect to the integrity of a National Sites Network site

8. Our assessment – part 5: Other environmental considerations

8.1. Non-radiological issues

Some environmental legislation that normally applies to waste or emissions does not apply when the waste is radioactive waste. We have, therefore, included a standard condition in our permits (condition 2.3.7) requiring the operator to minimise the risk of pollution from the non-radiological properties of the radioactive waste and from any non-radioactive substances associated with the disposal of the radioactive waste, to the extent that this is not addressed by other environmental permits.

Condition 2.3.7 reflects the requirement in government guidance that we consider the non-radioactive hazards associated with radioactive waste during our regulation. This is not a new requirement, but it is now considered preferable and more transparent to explicitly require operators to ensure operating techniques consider non-radioactive hazards. This is particularly important where, were it not for the presence of radioactivity, the process would be subject to other pollution control requirements. Clause I in the new condition 1.1.4 similarly reflects the obligations placed on us by the government guidance.

NNB GenCo (SZC) has also applied for an environmental permit for water discharge activities (WDA) for Sizewell C. It made that application at the same time as its application for a radioactive substances activity permit. The WDA permit application covers the effluent discharges that would be made from Sizewell C, including those made via the main outfall tunnel to the North Sea. The impacts of the significant non-radiological properties and content of the proposed discharges are being assessed in the determination of the WDA application and would be controlled through a WDA permit.

We have also considered this application in the context of the government's policy to achieve net zero by 2050 as described in the Energy White Paper: Powering our Net Zero Future and the aims of the British Energy Security Strategy. The White Paper's 10-point plan states: "Nuclear power provides a reliable source of low-carbon electricity. We are pursuing large-scale nuclear, whilst also looking to the future of nuclear power in the UK through further investment in Small Modular Reactors and Advanced Modular Reactors'. The British Energy Security Strategy states an aim that by 2050, up to a quarter of the power consumed in Great Britain is from nuclear. As nuclear power generates electricity without the CO_2 emissions associated with fossil fuels, Sizewell C is expected to significantly contribute to the government's policy to achieve net zero and help deliver the British Energy Security Strategy.

8.2. Other statutory considerations

EA 95, Section 4: Principal aim of the Environment Agency ('sustainable development')

We are required to contribute towards achieving sustainable development, as considered appropriate by the Secretary of State and set out in guidance issued to us. 'The

Environment Agency's Objectives and Contribution to Sustainable Development: Statutory Guidance' (issued by Defra in December 2002) provides guidance to us on such matters as the formulation of approaches that we should take to our work, decisions about our priorities and our allocation of resources. It is not directly applicable to our individual regulatory decisions.

The statutory guidance states that our main contribution to sustainable development will be to achieve our various objectives in a way that takes account (subject to and in accordance with EA 95 and any other enactment) of economic and social considerations. In respect of radioactive substances regulation, the guidance refers to the objective of regulating aerial and liquid radioactive discharges and solid radioactive waste disposal in accordance with statutory duties, statutory guidance and UK government policy.

We consider that the overall approach described in this document and, in particular, the application of BAT, which takes into consideration social and economic factors, and the assessment of the impact of the discharges on members of the public and environment, contribute appropriately to the aim of achieving sustainable development, having regard to the statutory guidance.

EA 95, Section 5: Pollution control powers

Section 5 of EA 95 sets out the purpose for which our pollution control powers, including our powers under EPR 2016, must be used. This is for 'preventing or minimising, or remedying or mitigating the effects of, pollution of the environment'. We consider that we have proposed proper use of our pollution control powers for that purpose, in that:

- we have proposed draft limits and conditions based on BAT, as specified in the statutory guidance, and having regard to government policy
- the impact of the proposed discharges on members of the public would be as low as reasonably achievable (ALARA), taking social and economic factors into account
- the environment would be protected

EA95, Section 7(1)(c)(ii): Amenity

Under section 7(1)(c)(ii) of EA 95, we must take into account any effect which our proposals would have on the amenity of any rural or urban area.

We do not consider that any additional or different limits or conditions are required in the draft permit, in relation to this duty.

EA 95, Section 7(1)(c)(iii): Well-being of local communities

Under section 7(1)(c)(iii) of EA 95, we must have regard to the effect our proposals would have on the economic and social well-being of local communities in rural areas.

We have had regard, as appropriate, to the potential effect on the economic and social well-being of the local community as part of:

- our assessment of NNB GenCo (SZC)’s proposals in relation to the use of BAT, which involves considering costs and benefits
- our considerations in relation to the principal aim of the Environment Agency (sustainable development)
- our assessment of the impact of disposals

We do not consider that any additional or different limits or conditions are required in the draft permit, in relation to this duty.

EA 95, Section 39: Likely costs and benefits

We have a duty to take into account the likely costs and benefits of whether and how we exercise our powers (‘costs’ being defined as including costs to the environment as well as to any person). This duty, however, does not affect our obligation to discharge any duties imposed upon us in other legislative provisions.

We have taken into account the likely costs and benefits in our assessment of BAT. We are satisfied that the conditions in the draft permit are proportionate.

Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 and Groundwater Directive (schedule 22 to EPR 2016)

Under the Water Environment (Water Framework Directive) Regulations 2017 (UK Parliament, 2017), we must exercise our functions to secure compliance with the Water Framework Directive (Directive 2000/60/EC), which seeks to protect groundwater and surface water on an integrated river basin management basis, the Environmental Quality Standards Directive (Directive 2008/105/EC) and the Groundwater Directive (Directive 2006/118/EC). We have considered NNB GenCo (SZC)’s proposals in relation to the use of BAT to minimise discharges of radioactivity to the environment and the impact of these discharges on members of the public and the environment. As stated earlier, we consider that NNB GenCo (SZC)’s proposals represent the use of BAT to reduce the impact to as low as reasonably achievable in line with the draft permit’s requirements. We are, therefore, satisfied that the conditions are sufficient in relation to the requirements of the Regulations, and that granting the permit with the conditions proposed would not cause the current status of the water body (that is, the coastal waters close to Sizewell C site) to deteriorate or compromise achievement of environmental objectives of the water bodies.

Schedule 22 of EPR 2016 implements the Groundwater Directive to require the taking of all necessary measures to prevent the input of any hazardous substances, which includes radioactive substances, entering groundwater, and to limit non-hazardous pollutants entering groundwater, so they do not cause pollution. No releases to groundwater from the radioactive substances activities are applied for or permitted by the draft permit.

Human Rights Act 1998

We have considered potential interference with rights addressed by the European Convention on Human Rights in reaching our decision. We consider that our decision is compatible with our duties under the Human Rights Act 1998 (UK Parliament, 1998). In particular, we have considered the right to life (Article 2), the right to a fair trial (Article 6) (which here includes the right to a reasoned decision – as provided in draft in this document), the right to respect for private and family life (Article 8) and the right to protection of property (Article 1, First Protocol).

Public participation and duty to involve

Regulation 60 of EPR 2016 requires us to prepare and publish a statement of our policies for complying with our public participation duties. We have published '[Environmental Permits: how and when we consult]()' and this application is being consulted upon in line with it, as a site of high public interest.

Section 23 of the Local Democracy, Economic Development and Construction Act 2009 (UK Parliament, 2009d) requires us, where we consider it appropriate, to take such steps as we consider appropriate to secure the involvement of interested persons in the exercise of our functions by providing them with information, consulting them or involving them in any other way.

We have described our consultation in relation to this application in chapter 3 of this document. We have described the way in which we have taken account of representations we have received in Appendix 1.

Deregulation Act 2015 – Growth duty

We considered our duty to have regard to the desirability of promoting economic growth set out in section 108(1) of the Deregulation Act 2015 (UK Parliament, 2015b) and the guidance issued under section 110 of that Act in deciding whether to grant this permit.

Paragraph 1.3 of the guidance says:

"The primary role of regulators, in delivering regulation, is to achieve the regulatory outcomes for which they are responsible. For a number of regulators, these regulatory outcomes include an explicit reference to development or growth. The growth duty establishes economic growth as a factor that all specified regulators should have regard to, alongside the delivery of the protections set out in the relevant legislation."

We have addressed the legislative requirements and environmental standards to be met in chapters 4 to 8 of this document. Paragraph 1.5 of the guidance is clear that encouraging economic growth should not be pursued at the expense of protecting the environment.

We consider the requirements and standards we have set in this permit are reasonable and necessary to protect the environment and people. This also promotes growth among legitimate applicants and operators because the standards applied to the applicant are consistent across businesses in this sector and have been set to achieve the required legislative standards.

Equality Act 2010

We have had regard to the Public Sector Equality Duty and are satisfied that our proposed decision and decision-making process are in accordance with the duty. We carried out an equality analysis to help inform our engagement activities relating to the Sizewell C project.

8.3. Other matters

Matters such as nuclear safety, the location of the facility, traffic movements and flood risk are generally dealt with under other regimes and/or by other bodies and not as part of our RSR permitting remit. Where consultees have raised issues relating to such matters, we provide more information in Appendix 1.

9. Our proposed decision

Our proposed decision, subject to careful consideration of any issues that are identified through this consultation, is that we should grant the application and issue a permit. A draft permit containing our proposed conditions is available on our Sizewell C proposed decision consultation pages on our online consultation hub.

9.1. Conditions of draft permit

The draft permit is based on our standard template permit for radioactive substances activities carried out on a nuclear site. We have developed the standard template over a number of years and we regularly review it to make sure that it is up to date and effective, and that permits for specific sites properly protect people and the environment and are consistent with the relevant government policies. The permit template and its conditions are described more fully in the document How to comply with your environmental permit for radioactive substances on a nuclear licensed site.

The standard permit template consists, principally, of:

- an introductory note (this is not part of the permit)
- a certificate page, authorising the permit
- Parts 1 to 4, being standard conditions about management, operations, disposals and monitoring, and provision of information
- Schedule 1, defining the activities permitted
- Schedule 3, specifying routes for, and limits on, disposals
- Schedule 7, being a site plan showing the geographical extent of the regulated facility

The conditions in Parts 1 to 4 of the draft permit have not been modified from the standard conditions of our template.

In Schedule 1, we have included 16 information/improvement requirements for the reasons explained in chapters 4 to 8.

Schedule 3 specifies the approved waste types and disposal routes and, as relevant, the limits that apply to specific radionuclides or groups of radionuclides for each of the approved disposal routes. We have also included quarterly notification levels (QNLs) for discharge of gaseous and aqueous wastes into the environment. The purpose of QNLs is described in section 6.3 of this document.

We are of the view that our proposed decision and draft permit conditions are consistent with the relevant legislation, and that we have reached the proposed decision having regard to the statutory guidance concerning the regulation of radioactive discharges into the environment and relevant government policy.

References

Allott, R., Cailes, C., Titley, J. and Rowe, J. 2019.
Habitats assessments for radioactive substances: 2017 review. Version 1.0. Bristol: Environment Agency.

Brown, J.E., Alfonso, B., Availa, R., Beresford, N.A., Copplestone, D. and Hosseini, A. 2016.
A new version of the ERICA tool to facilitate impact assessments of radioactivity on wild plants and animals. Journal of Environmental Radioactivity, Volume 153, pages 141-148.
http://www.erica-tool.com/

Byrom, J., Robinson, C., Simmonds, J., Walters, B., Taylor, R.R.1995.
Food consumption rates for use in generalised radiological dose assessments. Journal of Radiological Protection, Volume 15, Number 4. Pages 335-342.
https://iopscience.iop.org/article/10.1088/0952-4746/15/4/005/pdf

Cambridge Environmental Research Consultants (CERC), 2010.
Atmospheric Dispersion Modelling System. http://cerc.co.uk/environmental-software/ADMS-model.html

Department of Energy and Climate Change (DECC), 2010.
The Justification of Practices Involving Ionising Radiation Regulations 2004. The reasons for the Secretary of State's Decision as Justifying Authority on the Regulatory Justification of the Class or Type of Practice being: "The generation of electricity from nuclear energy using oxide fuel of low enrichment in fissile content in a light water cooled, light water moderated thermal reactor currently known as the EPR designed by AREVA NP." London: Department of Energy and Climate Change.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47936/666-decision-EPR-nuclear-reactor.pdf

Environment Agency, 2006.
Initial radiological assessment methodology – Part 1 User report and Part 2 Methods and input data (science report SC030162). Bristol: Environment Agency.
https://www.gov.uk/government/publications/initial-radiological-assessment-methodology

Environment Agency, 2010a.
Working together: your role in our environmental permitting (edition 2). Bristol: Environment Agency.
https://www.gov.uk/government/publications/environmental-permitting-public-participation-statement

Environment Agency, 2010b.
RSR: Management arrangements at nuclear sites (version 2). Bristol: Environment Agency.
https://www.gov.uk/government/publications/rsr-management-arrangements-for-nuclear-sites

Environment Agency, 2010c.
RSR: Principles of optimisation in the management and disposal of radioactive waste (version 2). Bristol: Environment Agency.
https://www.gov.uk/government/publications/rsr-principles-of-optimisation

Environment Agency, 2011.
Decision Document: Generic design assessment: UK EPR^{TM} nuclear power plant design by AREVA NP SAS and Electricité de France SA. Bristol: Environment Agency.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296896/geho1211btno-e-e.pdf

Environment Agency, 2012a.
Supplement to the Decision Document: Generic design assessment: UK EPR^{TM} nuclear power plant design by AREVA NP SAS and Electricité de France SA. Bristol: Environment Agency.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/297630/LIT_7565_98854f.pdf

Environment Agency, 2012b.
Regulatory Guidance Series RSR 2: The regulation of radioactive substances activities on nuclear licensed sites (version 2). Bristol: Environment Agency.
https://www.gov.uk/government/publications/rgn-rsr-2-regulation-of-radioactive-substances-activities-on-nuclear-licensed-sites

Environment Agency, 2012c.
Criteria for setting limits on the discharge of radioactive waste from nuclear sites. Bristol: Environment Agency.
https://www.gov.uk/government/publications/discharge-of-radioactive-waste-from-nuclear-sites-setting-limits

Environment Agency, 2016.
Legal operator and competence requirements: environmental permits (web guide). Bristol: Environment Agency.
https://www.gov.uk/guidance/legal-operator-and-competence-requirements-environmental-permits

Environment Agency, 2019.
Environmental permits: when and how we consult (web guide). Bristol: Environment Agency.
https://www.gov.uk/government/publications/environmental-permits-when-and-how-we-consult

Environment Agency, 2021a.
Radioactive substances regulation (RSR): objective and principles (web guide). Bristol: Environment Agency.
Radioactive substances regulation (RSR): objective and principles - GOV.UK (www.gov.uk)

Environment Agency, 2021b.
Radioactive substances regulation (RSR) generic developed principles: regulatory assessment (web guide). Bristol: Environment Agency.
RSR generic developed principles: regulatory assessment - GOV.UK (www.gov.uk)

Environment Agency, 2022.
Radiological Impact Assessment for Proposed Sizewell C Nuclear Power Station. Bristol: Environment Agency.
https://consult.environment-agency.gov.uk/psc/sizewell-c-environmental-permits-information-page/

Environment Agency, SEPA & Food Standards Agency, 2010.
Radiological monitoring technical guidance note 2 – Environmental radiological monitoring. Bristol: Environment Agency.
http://www.sepa.org.uk/media/101506/radiological_monitoring_technical_guidance_note_2_environmental-radiological-monitoring.pdf

Environment Agency, Scottish Environment Protection Agency, Northern Ireland Environment Agency, Food Standards Agency and Health Protection Agency, 2012. Principles for the Assessment of Prospective Public Doses arising from Authorised Discharges of Radioactive Waste to the Environment (Issue 2). Penrith: Environment Agency.
https://www.gov.uk/government/publications/assessment-of-prospective-public-doses-from-authorised-discharges

Environment Agency and SEPA, 2010.
Radiological monitoring technical guidance note 1 – Standardised reporting of radioactive discharges from nuclear sites. Bristol: Environment Agency & SEPA.
http://www.sepa.org.uk/media/101584/radiological_monitoring_technical_guidance_note_1_standardised_reporting_of_radioactive_discharges_from_nuclear_sites.pdf

Environment Agency, Food Standards Agency, Food Standards Scotland, Natural Resources Wales, Northern Ireland Environment Agency and Scottish Environment Protection Agency, 2018a.
RIFE-23, Radioactivity in Food and the Environment.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/750730/Radioactivity_in_food_and_the_environment_2017_RIFE_23.pdf

Environment Agency, Natural Resources Wales, Northern Ireland Environment Agency and Scottish Environment Protection Agency, 2018b.
Environment Agencies' Statement on Radioactive Waste Advisers. Document Ref: RWA-S-1 Version 2. 2018.
https://www.sepa.org.uk/media/160502/environment-agencies-statement-on-rwas.pdf

Environment Agency, Food Standards Agency, Food Standards Scotland, Natural Resources Wales, Northern Ireland Environment Agency and Scottish Environment Protection Agency, 2019.
RIFE-24, Radioactivity in Food and the Environment.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/843281/Radioactivity_in_food_and_the_environment_2018_RIFE_24.pdf

Environment Agency, Food Standards Agency, Food Standards Scotland, Natural Resources Wales, Northern Ireland Environment Agency and Scottish Environment Protection Agency, 2020.
RIFE-25, Radioactivity in Food and the Environment.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/932885/Radioactivity_in_food_and_the_environment_2019_RIFE_25.pdf

Council of the European Union, 2009.
Council directive establishing a Community framework for the nuclear safety of nuclear installations (2009/71/ Euratom). Official Journal of the European Union, L 172, 18 – 22.
https://osha.europa.eu/en/legislation/directives/council-directive-2009-71-euratom

European Commission, 2010.
Commission recommendation on the application of article 37 of the Euratom treaty (2010/635/Euratom). Official Journal of the European Union, L 279, 36 – 67.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:279:0036:0067:EN:PDF

Council of the European Union, 2011.
Council directive establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste (2011/70/Euratom). Official Journal of the European Union, L 199, 48 – 56.
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011L0070&qid=1397211079180

Council of the European Union, 2013.
Council directive laying down basic safety standards for the protection against the dangers arising from ionising radiation (2013/59/Euratom). Official Journal of the European Union, L 159, 1 – 114.
https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2014:013:0001:0073:EN:PDF

European Commission, 2021.
Commission Opinion of 3 June 2021 relating to the plan for the disposal of radioactive waste arising from the Sizewell C power station site (two UK EPR reactors), located in Suffolk, United Kingdom. Official Journal of the European Union. 2021/C 221/01. Brussels.
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021A0610(01)

Garrod, C.J., Clyne, F.J. and Rumney, P. 2016.
Radiological Habits Survey: Sizewell, 2015. Cefas: Lowestoft
https://www.cefas.co.uk/publications/environment/sizewell2015.pdf

UK Parliament, 1949.
House of Commons. National Parks and Access to the Countryside Act 1949. London: The Stationery Office.
http://www.legislation.gov.uk/ukpga/Geo6/12-13-14/97/contents

UK Parliament, 1981.
Great Britain. Parliament. House of Commons. Wildlife and Countryside Act 1981. London: The Stationery Office.
http://www.legislation.gov.uk/ukpga/1981/69/contents

UK Parliament, 1995a.
House of Commons. Environment Act 1995. London: The Stationery Office.
http://www.legislation.gov.uk/ukpga/1995/25/contents

UK Parliament, 1995b.
House of Commons. Review of Radioactive Waste Management Policy. Final Conclusions. Command 2919. London: The Stationery Office.
https://www.gov.uk/government/publications/radioactive-waste-management-policy-review-1994

UK Parliament, 1998.
House of Commons. Human Rights Act 1998. London: The Stationery Office.
http://www.legislation.gov.uk/ukpga/1998/42/contents

UK Parliament, 2000.
House of Commons. Countryside and Rights of Way Act 2000. London: The Stationery Office.
http://www.legislation.gov.uk/ukpga/2000/37/contents

UK Parliament, 2004.
House of Commons. Statutory Instrument 2004 No. 1769. The Justification of Practices Involving Ionising Radiation Regulations 2004. London: The Stationery Office.
http://www.legislation.gov.uk/uksi/2004/1769/made

UK Parliament, 2006.
House of Commons. Natural Environment and Rural Communities Act 2006. London: The Stationery Office.
http://www.legislation.gov.uk/ukpga/2006/16/contents

UK Parliament, 2007.
House of Commons. Department for Environment, Food and Rural Affairs, Department of Trade and Industry, and the devolved administrations.
Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom. London: Department for Environment, Food and Rural Affairs
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/254393/Low_level_waste_policy.pdf

UK Parliament, 2009a.
House of Commons. Department of Energy and Climate Change, 2009. Statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment. London: Department of Energy and Climate Change.
http://webarchive.nationalarchives.gov.uk/20121217150421/http://decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/nuclear/radioactivity/dischargesofradioactivity/1_20091202160019_e_@@_guidanceearadioactivedischarges.pdf

UK Parliament, 2009b.
House of Commons. Department of Energy and Climate Change, Welsh Assembly Government, Department of the Environment (Northern Ireland) & the Scottish Government.
UK Strategy for radioactive discharges. London: Department of Energy and Climate Change.
http://www.gov.scot/Resource/Doc/280203/0084414.pdf

UK Parliament, 2009c.
House of Commons. Marine and Coastal Access Act 2009. London: The Stationery Office.
http://www.legislation.gov.uk/ukpga/2009/23/contents

UK Parliament, 2009d.
House of Commons. Local Democracy, Economic Development and Construction Act 2009. London: The Stationery Office.
http://www.legislation.gov.uk/ukpga/2009/20/contents

UK Parliament, 2010.
House of Commons. Statutory Instrument 2010 No. 1627. The Marine Strategy Regulations 2010. London: The Stationery Office.
http://www.legislation.gov.uk/uksi/2010/1627/contents

UK Parliament, 2011.
House of Commons. Department for Environment, Food and Rural Affairs. Environmental Permitting Guidance – Radioactive Substances Regulation (version 2). London: Defra
https://www.gov.uk/government/publications/radioactive-substance-regulations-rsr-guidance

UK Parliament, 2015a.
House of Commons. Department of Energy and Climate Change. 2010 to 2015 Government policy: radioactive and nuclear substances and waste. London: DECC.
https://www.gov.uk/government/publications/2010-to-2015-government-policy-radioactive-and-nuclear-substances-and-waste/2010-to-2015-government-policy-radioactive-and-nuclear-substances-and-waste

UK Parliament, 2015b.
House of Commons. Deregulation Act 2015. London: The Stationery Office.
http://www.legislation.gov.uk/ukpga/2015/20/contents

UK Parliament, 2016a.
House of Commons. Statutory Instrument 2016 No. 1154. The Environmental Permitting (England and Wales) Regulations 2016. London: The Stationery Office.
http://www.legislation.gov.uk/uksi/2016/1154/contents/made

UK Parliament, 2016b.
House of Commons. Department of Energy and Climate Change, the Scottish Government, the Welsh Government, & Department of the Environment (Northern Ireland). UK Strategy for the management of solid low level waste from the nuclear industry. London: Department of Energy and Climate Change.
https://www.gov.uk/government/consultations/consultation-on-an-update-of-the-uk-strategy-for-the-management-of-solid-low-level-radioactive-waste-from-the-nuclear-industry

UK Parliament, 2017.
House of Commons. Statutory Instrument 2017 No. 407. The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. London: The Stationery Office.
https://www.legislation.gov.uk/uksi/2017/407/contents/made

UK Parliament, 2017a.
House of Commons. Statutory Instrument 2017 No. 1075. The Ionising Radiations Regulations 2017. London: The Stationery Office.
https://www.legislation.gov.uk/uksi/2017/1075/contents

UK Parliament, 2017b.
House of Commons. Statutory Instrument No. 1012. The Conservation of Habitats and Species Regulations 2017. London: The Stationery Office.
https://www.legislation.gov.uk/uksi/2017/1012/contents

UK Parliament, 2018.
House of Commons. Statutory Instrument 2018 No. 430. The Justification of Practices Involving Ionising Radiation (Amendment) Regulations 2018. London: The Stationery Office.
https://www.legislation.gov.uk/uksi/2018/430/contents/made

UK Parliament, 2018a.
House of Commons. Department for Business, Energy & Industrial Strategy.
UK Strategy for Radioactive Discharges 2018 Review of the 2009 Strategy' London: Department for Business, Energy & Industrial Strategy.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718723/2018Rev2009UKStratRadDischargeFin.pdf

UK Parliament, 2018b.
House of Commons. Department for Business, Energy & Industrial Strategy. Standardised Reporting of Radioactive Discharges Direction 2018. London: Department for Business, Energy & Industrial Strategy.
https://www.gov.uk/government/publications/standardised-reporting-of-radioactive-discharges-direction-2018

UK Parliament, 2019.
House of Commons. Department for Business, Energy & Industrial Strategy. 2018
The Justification of Practices involving Ionising Radiation Regulations 2004 Guidance on their application and administration' London: Department for Business, Energy & Industrial Strategy.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/717288/180618_JustificationGuidanceDoc_updatedannex.pdf

UK Parliament, 2020.
House of Commons. Department for Environment, Food and Rural Affairs.
Environmental Permitting Guidance – Core guidance. London: Defra.
https://www.gov.uk/government/publications/environmental-permitting-guidance-core-guidance–2

UK Parliament, 2021.
House of Commons. Department for Business, Energy & Industrial Strategy.
How we regulate radiological and civil nuclear safety in the UK. Guidance. London: Department for Business, Energy & Industrial Strategy.
How we regulate radiological and civil nuclear safety in the UK (webpage) - GOV.UK (www.gov.uk)

UK Parliament, 2022.
House of Commons. Nuclear Energy (Financing) Act 2022. London: The Stationery Office.
https://www.legislation.gov.uk/ukpga/2022/15/enacted
Health Protection Agency, 2008.
Guidance on the Application of Dose Coefficients for the Embryo, Fetus and Breastfed Infant in Dose Assessments for Members of the Public. Advice from the Health Protection Agency, RCE-5. Chilton: Health Protection Agency.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/335131/RCE-5_dosecoef.pdf

Health Protection Agency, 2009.
Application of the 2007 ICRP Recommendations to the UK – Advice from the Health Protection Agency, RCE-12. Chilton: Health Protection Agency
https://www.gov.uk/government/publications/international-commission-on-radiological-protection-2007-recommendations

International Atomic Energy Agency, 1997.
Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Vienna: International Atomic Energy Agency.
https://www.iaea.org/sites/default/files/infcirc546.pdf

International Atomic Energy Agency, 2001.
Generic Models for use in Assessing the Impact of Discharges of Radioactive Substances to the Environment. Safety Reports Series No. 19. Vienna: International Atomic Energy Agency.
https://www-pub.iaea.org/MTCD/publications/PDF/Pub1103_scr.pdf

International Atomic Energy Agency, 2004.
Management of Waste Containing Tritium and Carbon-14. Technical Reports Series No. 421. Vienna: International Atomic Energy Agency.
https://www-pub.iaea.org/MTCD/Publications/PDF/TRS421_web.pdf

International Atomic Energy Agency, 2018.
Prospective Radiological Environmental Impact Assessment for Facilities and Activities, IAEA Safety Standards Series No. GSG-10, IAEA, Vienna (2018).
Prospective Radiological Environmental Impact Assessment for Facilities and Activities | IAEA

International Commission on Radiological Protection, 2007.
The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103.
https://journals.sagepub.com/doi/pdf/10.1177/ANIB_37_2-4

International Commission on Radiological Protection, 2008.
Environmental Protection - the Concept and Use of Reference Animals and Plants. ICRP Publication 108. Ann. ICRP 38, 4-6.
https://www.icrp.org/publication.asp?id=icrp%20publication%20108

International Commission on Radiological Protection, 2012.
Compendium of Dose Coefficients based on ICRP Publication 60. ICRP Publication 119.
https://www.icrp.org/publication.asp?id=ICRP%20Publication%20119

National Dose Assessments Working Group, 2013.
Use of Habits Data in Prospective Dose Assessments. NDAWG Guidance Note 7. NDAWG Habits Subgroup.
https://www.phe-protectionservices.org.uk/cms/assets/gfx/content/resource_4613cseeaebbffb5.pdf

Oslo and Paris Commission, 2010.
The North-East Atlantic Environment Strategy: Strategy of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic 2010–2020 (OSPAR Agreement 2010-3). (Radioactive Substances Strategy included in Part 2 of the NEAE Strategy)
http://www.ospar.org./convention/strategy

Oslo and Paris Commission, 2016.
Overview of national statements on the implementation of PARCOM Recommendation 91/4. Publication Number: 726/2016. London.
https://www.ospar.org/documents?v=39834

Oslo and Paris Commission, 2021.
Strategy of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic
strategy_part_1__north-east_atlantic_2030_updated.pdf (ospar.org.)

Public Health England, 2016.
Ionising radiation exposure of the UK population: 2010 review, PHE-CRCE-026. London: Public Health England
https://www.phe-protectionservices.org.uk/cms/assets/gfx/content/resource_3595csc0e8517b1f.pdf

Smith, J. and others, 2004.
A Methodology for Assessing Doses from Short-Term Planned Discharges to Atmosphere. NRPB-W54. Chilton: National Radiological Protection Board.

Smith, K., Wood, M., Copplestone, D. and Smith, G (eds). 2016.
Scales for Post-closure Assessment Scenarios (SPACE) – Addressing spatial and temporal scales for people and wildlife in long-term safety assessments. Østerås, Norway: Norwegian Radiation Protection Authority.
https://www2.dsa.no/publication/nrpa-report-2016-2-scales-for-post-closure-assessment-scenarios-space.pdf

Smith, J. 2019.
Review of local compartment parameter values for use with UK sites in the DORIS marine dispersion model. PHE-CRCE-051. London: Public Health England
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/828908/Review_of_parameter_values_for_UK_sites__in_DORIS_marine_dispersion_model.pdf

Vives, J., Batlle, I. and others, 2015.
A method for estimating ^{41}Ar, $^{85,88}Kr$ and $^{131m,133}Xe$ doses to non-human biota. Journal of Environmental Radioactivity, Volume 144, June 2015, Pages 152-161.
https://www.sciencedirect.com/science/article/pii/S0265931X15000685#

Glossary

Term	Meaning
Activity	A generic title for the practices or operations which need to be permitted (unless exempted from the need for a permit).
ALARA	As low as reasonably achievable (economic and social factors being taken into account). Radiation doses comply with ALARA when they have been reduced to a level that represents a balance between dose and other factors. This is a statement of the optimisation principle.
ALARP	As low as reasonably practicable.
AONB	Area of Outstanding Natural Beauty.
APG	Steam Generator Blowdown System.
BAT	Best available techniques – see ‘Schedule 6 – Interpretation’ in the draft permit for a full definition.
BEIS	Department for Business, Energy and Industrial Strategy.
Bq, kBq, MBq, GBq and TBq	Abbreviations meaning Becquerels, kilo (10^3) Becquerels, mega (10^6) Becquerels, giga (10^9) Becquerels and tera (10^{12}) Becquerels respectively. 1Bq is one atomic disintegration per second.
BSSD	Basic Safety Standards Directive (Directive 2013/59/EURATOM, EU, 2013).
Care and maintenance (C&M)	A stage of the decommissioning process for a nuclear site where physical decommissioning of the site has ceased but it is monitored and maintained to ensure it remains safe and any discharges to the environment are minimal.
Cefas	Centre for Environment, Fisheries and Aquaculture.
CGN	China General Nuclear Power Corporation.

COMARE	Committee of Medical Aspects of Radiation in the Environment.
CRCE	Centre for Radiation, Chemical and Environmental Hazards (part of Public Health England).
CRP	Candidate representative person.
CRWA	Corporate Radioactive Waste Adviser. An approved system of arrangements where more than one individual carries out the Radioactive Waste Adviser function on behalf of a permit holder.
CVCS	Chemical and volume control system.
CVI	Condenser vacuum.
DCO	Development Consent Order.
Direct radiation	Exposure occurring as a result of direct or reflected gamma radiation from the facilities within the regulated site. Regulated by the Office for Nuclear Regulation (ONR).
DWI	Interim storage facility for ILW ventilation system.
DWN	Nuclear auxiliary building ventilation system.
EDF	Electricité de France.
EPR^{Tm}	European Pressurised Reactor.
EPR 2016	Environmental Permitting (England and Wales) Regulations 2016.
EPRI	Electric Power Research Institute.
FSA	Food Standards Agency.
FWP	Forward Work Plan.
GDA	Generic Design Assessment.

GDF	Geological disposal facility.
GRA	Guidance on Requirements for Authorisation. Environment Agency guidance detailing the environmental objectives which an underground facility for the permanent disposal of radioactive waste must achieve. There are 2 versions of the GRA: one for geological disposal of higher activity radioactive waste; and one for near-surface disposal of lower activity radioactive waste.
Gy, μGy	Abbreviation meaning gray, microgray. A unit of absorbed dose.
'Group most exposed to'	The group of the public most exposed to ionising radiation from a single type of discharge pathway (for example, discharges to the marine environment).
HEPA	High-efficiency particulate in air.
HHI	Interim storage facility for ILW.
HLW	High level radioactive waste.
HPA	Health Protection Agency (superseded by Public Health England and then by the UK Health Security Agency).
HPC	Hinkley Point C.
HQA	Radioactive waste storage building.
HRA	Habitats Regulations Assessment.
HSE	Health and Safety Executive. Regulator with responsibilities under IRR17 (UK Parliament 2017b).
ICRP	International Commission on Radiological Protection.
ILW	Intermediate level radioactive waste.
IRWST	In-containment refuelling storage water tank.

iSoDA	Interim Statement of Design Acceptability.
IWS	Integrated waste strategy.
Justification	The benefits and detriments of any practice which could result in exposure to ionising radiation must by assessed prior to the practice being permitted. If the benefits outweigh the detriments, the practice is justified.
KER	Liquid radwaste monitoring and discharge system.
Licensee	An operator licensed under NIA 65.
LLW	Low level radioactive waste.
LLWR	Low Level Radioactive Waste Repository.
LoC	Letter of Compliance.
person.Sv	Person Sievert – a measure of collective dose to a population.
MCERTs	The Environment Agency's Monitoring Certification Scheme.
MCZ	Marine Conservation Zone.
MPL	European Union's maximum permitted level of radioactivity in food following a radiological emergency.
Mwe	Megawatt electrical, a measure of electrical power.
NAIR	National Arrangements for Incidents involving Radioactivity.
NIA 65	The Nuclear Installations Act 1965.
NDA	Nuclear Decommissioning Authority.
NDAWG	National Dose Assessments Working Group.
NSC	Nuclear Safety Committee.
NSSS	Nuclear steam supply system.

Nuclear island	The facilities within the reactor and associated buildings.
NWS	Nuclear Waste Services Ltd. A division of the NDA created in January 2022.
ONR	Office for Nuclear Regulation: a statutory public corporation, responsible for regulation of nuclear safety and security across the UK.
OPEX	Operational experience.
OSPAR	Oslo and Paris Convention for the protection of the marine environment in the north-east Atlantic. The UK is a signatory to this Convention, whose strategies aim to prevent pollution of the maritime area by continuously reducing discharges, emissions and losses of chemically hazardous substances and radioactive substances.
PAP	Procedure Adoption Plan.
PCER	Pre-Construction Environmental Report.
PHE	Public Health England (which superseded the Health Protection Agency (HPA) in 2013) and which became part of the UK Health Security Agency in 2021.
Plume	The location of the volume of air and ground surface where aerial discharges may be expected.
Proximity principle	The aim of the proximity principle is to avoid excessive and unnecessary transportation of wastes for disposal. It means enabling waste to be disposed of in one of the nearest appropriate installations.
Public dose limit	UK dose limit for members of the public of 1,000μSv per year as mandated by the Environmental Permitting (England and Wales) Regulations 2016.
PWR	Pressurised Water Reactor.
QNL	Quarterly notification level.

RC	Reference configuration.
Representative person	The representative person is ‘an individual receiving a dose that is representative of the more highly exposed individuals in the population’.
RIFE	Radioactivity in Food and the Environment reports published each year.
RSR	Radioactive Substances Regulation.
RWA	Radioactive Waste Adviser. A person appointed by a permit holder or prospective permit holder to provide advice on radioactive waste management and environmental radiation protection.
RWM	Radioactive Waste Management Ltd.
RWMC	Radioactive Waste Management Case.
SAC	Special Area of Conservation.
SEK	Conventional island/site liquid waste discharge system.
Sievert (Sv)	A measure of radiation dose received. • millisievert (mSv): one thousandth of a Sievert • microsievert (μSv): one millionth of a Sievert • nanosievert (nSv): one thousand millionth of a Sievert
Site dose constraint	A restriction on annual dose to an individual from a single site such that when aggregated with doses from all sources, excluding natural background and medical procedures, the dose limit is not likely to be exceeded. A site constraint of 0.5mSv/y has been set in EPR 2016 and this applies to the aggregate exposure from a number of sources with contiguous boundaries at a single location, irrespective of whether different sources on the site are owned or operated by the same or by different organisations.
Sky shine	Ionising radiation (for example, gamma radiation) emitted from a site that is reflected or scattered back to the earth’s surface.

SoDA	Statement of Design Acceptability.
Source dose constraint	A restriction on annual dose to an individual from a single source such that when aggregated with doses from all sources, excluding natural background and medical procedures, the dose limit is not likely to be exceeded. A source constraint of 0.3mSv/y has been set in EPR 2016.
Source term	The types, quantities, and physical and chemical forms of the radionuclides present in a nuclear facility that have the potential to give rise to exposure to ionising radiation, radioactive waste or discharges.
SPA	Special Protection Area.
SQEP	Suitably qualified and experienced person(s).
SSCs	Structures, systems and components.
SSSI	Site of Special Scientific Interest.
Sustainable development	Development which meets the needs of the present without compromising the ability of future generations to meet their own needs. Specific to radioactive waste, the government's policy (Command 2919, UK Parliament 1995b) is to 'ensure that radioactive waste is managed safely and that the present generation, which receives the benefit of nuclear power, meets its responsibilities to future generations'.
SZC	Sizewell C.
TEG	Gaseous waste processing system.
TER	Additional liquid waste discharge system.
TEU	Liquid waste processing system.
WAL	Weekly advisory level.
Waste hierarchy	A principle of waste management which requires (in order of preference) wastes to be:

	• avoided • minimised • reused • recycled • disposed of
WDA	Water discharge activity.

Appendix 1 - Consultation on the application

The application was advertised and consulted on in accordance with our public participation statement and government consultation principles. The way in which this has been carried out and how we have carefully considered consultation responses in preparing our proposed decision are summarised in this appendix and section 3.5 of this document. Copies of all consultation responses have been placed on our public register except where the person making the response asked us not to do so. Responses made using our e-consultation tool can also be accessed online via our consultation hub:

How we publicised the consultation on the application

The consultation on the application was advertised by a notice on GOV.UK from 6 July to 2 October 2020 and by issuing a press release. The notice provided brief details of the application, told people where they could see a copy of the application and how to make comments. Copies of the application were made available for public inspection using our e-consultation tool via our consultation hub.

We publicised the consultation by issuing press releases, advertising in a local newspaper and writing directly to a number of organisations and individuals inviting them to participate. As the application was made at a time when the government had placed restrictions on the movements and activities of the public due to the Covid-19 pandemic, we were unable to hold a consultation drop-in session or place copies of the application in local libraries and institutions as we would usually. We held a public question and answer session by phone on 20 July 2020 and put in place processes to enable interested parties to respond to the consultation over the telephone. We asked NNB Gen Co (SZC) to make copies of the application available on USB sticks, which it did.

Who we consulted

We wrote to the following bodies informing them of the application and directing them to copies of the application online:

- Office for Nuclear Regulation
- Food Standards Agency
- Natural England
- Marine Management Organisation
- Centre for Environment, Fisheries and Aquaculture Science (Cefas)
- Eastern Inshore Fisheries and Conservation Authority (IFCA)
- Health and Safety Executive
- East Suffolk District Council
- Suffolk County Council
- Public Health England (now the UK Health Security Agency)
- Ipswich and East Suffolk Clinical Commissioning Group
- Anglian Water

- Department for Business, Energy and Industrial Strategy
- Committee on Medical Aspects of Radiation in the Environment
- Low Level Waste Repository Limited
- The Norfolk and Suffolk Broads National Park
- Historic England

We also emailed over 800 other interested groups, non-governmental organisations, councils, members of parliament, businesses and individuals informing them of the consultation and inviting them to participate.

Responses to the consultation on the application

We received 27 responses from organisations and individuals. These are summarised here, together with our consideration of them.

Topic: Regulatory Justification and operator competence

Raised by: Together Against Sizewell C, ANON-CVYN-9YEY-G, ANON-CVYN-9YEB-S, ANON-CVYN-9YEM-4, ANON-CVYN-9YES-A, ANON-CVYN-9YEG-X

Summary of issues raised

Consultees stated that the justification for the EPR^{TM} series 1 had not been made and some raised concerns that the applications for environmental permits were premature. A number of consultees raised concerns over EDF's competence as an operator. Reasons for consultees' concerns included EDF's record of managing radioactive wastes, its lack of experience in decommissioning nuclear power stations, its financial situation, and its record of conventional safety controls on the Hinkley Pont C site, along with the status of and issues encountered by other European EPR projects.

Our consideration of the issues

Justification is a matter for government and we discuss the status of the Regulatory Justification of the EPR™ reactor in chapter 4 of this document. This outlines that a Regulatory Justification is in place for the EPR™ reactor and it is considered justified by the Secretary of State.

In section 4.4 of this document we discuss why we believe that there are significant benefits from regulating NNB GenCo (SZC) at an early stage of its development as an organisation.

We have considered the information provided by consultees regarding concerns about EDF. In the operator and operator competence section of chapter 4 of this document we provide an assessment of the suitability of the NNB GenCo (SZC) organisation and its developing arrangements to hold a permit and state that we consider NNB GenCo (SZC) to be a suitable organisation.

Topic: Optimisation and use of BAT

Raised by: ANON-CVYN-9YES-A, Committee on Medical Aspects of Radiation in the Environment (COMARE) Authorisations Working Group (AWG)

Summary of issues raised

Some consultees commented that the application did not demonstrate how EDF had reduced discharges and impact to as low as reasonably achievable, nor demonstrate how the proposed operation of the UK EPRs™ at Sizewell C has been optimised to minimise waste or that BAT has been applied. Some consultees stated that further measures could be taken to reduce radioactive discharges (although no specific measures were identified by consultees) and that EDF should investigate increasing the measures they take to minimise discharges.

The COMARE AWG commented that it was not clear in the application how minimisation of disposals within environmental optimisation fits with the type of optimisation that requires doses and risks to both workers and public to be minimised at the same time. They queried whether 'big picture' optimisation had been considered by NNB GenCo (SZC) and stated there was limited detail provided on what impact any measures for waste minimisation and reducing public radiation dose might have on staff radiation doses. The COMARE AWG also commented that non-radiological risks did not appear to have been considered in the optimisation process.

Our consideration of the issues

NNB GenCo (SZC) provided information on optimisation and use of BAT in the Environment Case document submitted as part of its application. NNB GenCo (SZC) has stated in the Head Document part of its application that "Optimisation of protection is conducted on the basis that radiological doses and risks to workers and members of the public from a source of exposure should be kept as low as reasonably achievable (the ALARA principle)". Arguments and evidence have been provided in the Environment Case that support this assertion; for example, a fundamental method of protecting the environment is to minimise the generation of radioactive waste. This can be achieved by a reduction in the source term through good coolant chemistry control, material selection and corrosion prevention, which both reduces radioactive waste and discharges, but also reduces the doses to the workers on the plant. Environmental objectives and radiation protection of workers are aligned.

The Environment Case also provides examples of consideration of worker doses in the waste management techniques for solid waste management and the handling of ILW. It describes how learning from other sites has been incorporated to minimise worker dose during the management and maintenance of discharge abatement equipment, for example, in paragraph 602, the number and size of resin beds are optimised to protect workers. We are satisfied that NNB GenCo (SZC) is adequately considering the impact on worker dose when determining BAT.

The Environment Case provides some examples where non-radiological considerations have been included based on learning from other nuclear facilities. An example is the replacement of hydrogen with nitrogen in the volume control tanks and as purge and sweeping gas, which has reduced the non-radiological risks from the storage of hydrogen.

The Sizewell C design and the application of BAT described in the Environment Case are based on Hinkley Point C, through the process of replication. We have reviewed the design change process applied by NNB GenCo (SZC) where the replicated design is amended and we are satisfied it adequately addresses non-radiological aspects of environmental protection.

NNB GenCo (SZC) have made a commitment to provide us with an optimised integrated waste strategy that also considers non-radioactive wastes. This should ensure that that disposals of radioactive and non-radioactive waste from the site are fully optimised. The draft permit also requires the development of a Waste Management Plan, our guidance associated with this strongly encourages it to take an integrated approach to the management of all wastes, both radioactive and non-radioactive, over the lifetime of the site.

Chapter 5 provides our consideration of NNB GenCo (SZC)'s proposals and why we consider at this stage that these demonstrate BAT. We have worked closely with the Office for Nuclear Regulation throughout the Generic Design Assessment (GDA) process, and in our assessment and regulation of Hinkley Point C, to ensure that high standards of environmental and public protection have been applied to the design and construction of the UK EPR™. We will continue to do this for Sizewell C.

Topic: Disposals of radioactive waste

Raised by: ANON-CVYN-9YE8-F, ANON-CVYN-9YEQ-8, Suffolk Coastal Friends of the Earth, ANON-CVYN-9YEA-R, ANON-CVYN-9YES-A, Committee on Medical Aspects of Radiation in the Environment (COMARE) Authorisations Working Group (AWG), BHLF-CVYN-9YER-9

Summary of issues raised

A number of consultees raised concerns about the safety and sustainability of the proposed disposal options for radioactive wastes which would be generated at Sizewell C, with one consultee stating that there was no solution for radioactive waste. Suffolk Coastal Friends of the Earth raised particular concerns over the disposal of wet sludge, requesting reassurance over the disposal plans for any sludges. Suffolk Coastal Friends of the Earth also commented that the Swedish method of packing high level waste canisters prior to their encapsulation has a poor track record and that the application mentions an encapsulation facility which is not specified on the site plan.

The COMARE AWG highlighted the lack of UK progress towards a long-term storage facility for intermediate and high level radioactive waste and commented that the long-term storage of wastes on site and the integrated waste strategy should be kept under review.

One consultee asked whether boron would be used to moderate the proposed reactors at Sizewell C and if this boron would subsequently be discharged to sea. They also asked whether there was any detriment to the reactor internals through the use of boric acid.

Our consideration of the issues

The UK has established waste management and disposal arrangements for very low and low level radioactive wastes. Higher activity wastes are currently being stored on sites in line with the Government commitment to implementing geological disposal for the safe and secure management of higher-activity radioactive waste over the long term. Further information on the disposal of radioactive wastes can be found in the NDA Integrated Waste Management - Radioactive Waste Strategy.

NNB GenCo (SZC) has stated that radioactive waste sludge will be either treated and disposed of off-site as LLW or, where the levels of radioactivity are higher, it will be encapsulated resulting in a dry waste form, which will be stored in the ILW waste store until it is able to be disposed off-site as LLW. The store is sized for the wastes arising over the 60-year life of the plant including any wet sludges.

Nuclear Waste Services (NWS), a division of the Nuclear Decommissioning Authority (the public body responsible for the strategic management of radioactive waste), defines the acceptability of higher activity waste forms that are destined to be disposed in the future geological disposal facility. NWS takes learning from international experience, such as that to which the consultee refers in defining the acceptability of waste packages for disposal to the GDF. NWS has recently published a report on progress in providing a future geological disposal facility.

The NNB GenCo (SZC) application outlines that encapsulation of operational wastes will occur in the HQA/B building. When Sizewell C enters its decommissioning phase, which is currently estimated to be in 60+ years, it is currently planned in the Funded Decommissioning Plan that an encapsulation facility for decommissioning wastes will be built on site. A proposed location for this facility has not yet been chosen but is likely to be within the permitted area/nuclear licensed site.

We agree that the integrated waste strategy for Sizewell C should be kept under review, and we will ensure this as part of our routine regulatory business. NNB GenCo (SZC) has provided a commitment in its application to provide us with an optimised integrated waste strategy, considering both radioactive and non-radioactive wastes. The draft permit also requires the development of a Waste Management Plan, our guidance associated with this strongly encourages it to take an integrated approach to the management of all wastes, both radioactive and non-radioactive, over the lifetime of the site.

Boron in the form of boric acid is added to the primary coolant to control core reactivity in pressurised water reactors as part of normal operations. The addition of boric acid is proposed to be used at Sizewell C, consistent with the UK EPR™ design. The amount of boron used is reduced by using a boron recycling system, but also through the use of boric acid enriched in boron-10, which has a higher neutron capture cross section than boron-

11. NNB GenCo (SZC) has included information on discharges of boric acid resulting from this process in its application for a water discharge activity permit.

Topic: Limit setting

Raised by: Committee on Medical Aspects of Radiation in the Environment (COMARE) Authorisations Working Group (AWG), ANON-CVYN-9YEZ-H, ANON-CVYN-9YEV-D, ANON-CVYN-9YET-B, ANON-CVYN-9YES-A, PR3, PR6

Summary of issues raised

We received a number of comments relating to the discharge limits NNB GenCo (SZC) requested in its application. Consultees raised concerns that the limits requested are higher than the current limits permitted for the Sizewell B station and that the cumulative impact of all discharges must be considered.

Consultees commented that the limits set should be informed by science, rather than being seemingly negotiable in proportion to the amount of development proposed on any single site. One consultee commented that some of the limits requested exceed the expected best performance described in the application by around 17 fold and stated that this did not conform to the ALARA principle. Some consultees stated that the Environment Agency should set levels of exposure and determine limits based on these, rather than asking operators to adhere to the ALARA principle.

The COMARE AWG commented that the requested limits did not seem unreasonable, but noted that, as they are based primarily on modelling, the Environment Agency may wish to consider adding permit requirements to substantiate the use of these limits once operational experience (OPEX) becomes available.

The COMARE AWG highlighted that the margin between the expected best performance and the proposed limit for carbon-14 gaseous discharges is only a factor of 2 and asked for the rationale for this low margin. The COMARE AWG queried the assumptions made about the chemical form of carbon-14 released and asked for further evidence to support this. The COMARE AWG also queried how discharges are expected to change once operations cease and the site moves into decommissioning.

One consultee also raised a number of specific queries about the proposed radioactive discharges from the site, asking what the total gaseous and particulate alpha emissions would be in terms of volume over the lifetime of the plant, what isotopic form these emissions would be in, what size any particulates discharged would be, and how the size of the particles would be monitored.

Our consideration of the issues

The limits set for Sizewell B and proposed for Sizewell C should be compared, taking account of the power generated by the stations in addition to the impact of the discharges permitted. There is a relationship between the quantity of radioactivity in the reactor core and the amount of energy it has produced as a result of the fission process. Sizewell C would generate over two and a half times the electricity generated by Sizewell B. When normalised to the same power output, the limits for the EPR reactors at Sizewell C are more restrictive than those imposed on Sizewell B.

In setting limits, we must be satisfied that operators can comply with the proposed limits without unduly affecting their ability to operate. Therefore, we must set limits which provide sufficient headroom for normal operation, provided that the operator applies BAT to minimise the activity of radioactive waste discharged and the impact of the discharges is acceptable with regard to dose limits and constraints.

In considering the application, we assessed the combined radiological impacts of all 3 adjacent sites and compared them with the site dose constraint. Further details of our radiological impact assessment are set out in chapter 7. When considering the application, we act conservatively in estimating impacts of discharges by assuming the operator makes discharges at the permitted limits for the operational life of the station. In reality, discharges from nuclear sites are routinely considerably lower than the permitted limits because BAT is applied.

The UK government takes advice, via the UK Health Security Agency (formerly Public Health England's Centre for Radiation, Chemical and Environmental Hazards (CRCE)), from the International Commission on Radiological Protection, which reviews the scientific data and develops a consensus on radiological risks. The government sets public dose limits and constraints based on ICRP recommendations on the risks associated with exposure to ionising radiation in Schedule 23 of EPR 2016. The dose constraint for a single source (for example, Sizewell C) is 300microsieverts per year (µSv/y), for a group of sources at a single site (Sizewell A, B and C) it is 500µSv/y and the public dose limit is one mSv per year. If we were to set discharge limits based on these dose limits and constraints, they would be significantly higher than those we have proposed in the draft permit, and the doses would not be ALARA, taking social and economic factors into account.

The Environment Agency agrees with COMARE AWG that the limits should be reviewed when operational experience is available. We will do this as part of our routine regulatory business.

Our radiological impact assessment shows that carbon-14 discharges to air constitute the highest contribution to public dose, albeit the doses calculated are well within the source limit set out within EPR 2016. It is appropriate that the headroom on this limit is as low as reasonable, taking into account potential operational fluctuations in discharges from routine and non-routine operations. International data indicates that the airborne carbon-14 released from pressurised water reactors (PWRs) is predominantly hydrocarbons (75 to 95%), mainly methane, with a smaller fraction (5 to 25%) as carbon dioxide. The UK EPR assumes 80% of carbon-14 is expected to be discharged in the form of methane. This is within the range expected for a PWR based on published operating experience. Further information on how this issue was considered is provided in our responses in the radiological impact assessment topic section below.

We asked NNB GenCo (SZC) to provide further information on how discharges are expected to change once the site moves into decommissioning. It responded with the following:

“As described in our Development Consent Order application, during decommissioning radiological discharges are expected to be within the limits proposed for the operation of Sizewell C and as such are bounded by the operational radiological impact assessment presented in Sizewell C’s radioactive substances regulations environmental permit application.

Five years before the planned closure date for Sizewell C, a programme of preparatory work would be initiated to ensure that there is no delay to commencement of decommissioning following end of generation, and to ensure that the site is decommissioned as efficiently and economically as possible.

This will include a revision (if required) to any radioactive substances regulation environmental permit held by Sizewell C for waste discharge and disposal. At this time, we will be able to draw on direct OPEX from other EPRs undergoing decommissioning not only in the UK, but the wider world.”

We accept these assumptions and consider the proposed operational limits to be acceptable.

We sought further information from NNB GenCo (SZC) regarding the specific questions asked about the proposed radioactive discharges. It responded with the following information.

“On the basis of the continued improvements in the fuel cladding design, continual monitoring, coupled with no measured global alpha activity in gaseous effluents from PWRs to date, no measurable amount of alpha activity is expected to be discharged from Sizewell C to atmosphere, and is not presented as a significant group of radionuclides in the Generic Design Assessment (GDA), or the SZC radioactive substances regulations permit application.” We accepted this argument in December 2012, when we issued a Statement of Design Acceptability for the UK EPR Reactor Design (our decision is documented in our 2011 UK EPR™ decision document and 2012 Supplement to the Decision Document) and in the determination of the Hinkley Point C permit in 2013. We have not identified any evidence to change this position.

NNB GenCo (SZC) also said, “Treatment of potentially radioactive gases is implemented to ensure that the most hazardous isotopes are removed from effluent streams and contained within solid filters, such as high-efficiency particulate in air (HEPA) filters and activated charcoal adsorption. This will result in a distribution of particulates around the micron scale (order of a couple of μm’s), which is in line with the assumptions used in the Radiological Impact Assessment included in Support Document D1 of the Sizewell C Radioactive Substances Regulations Permit Application. The size of the particulates discharged from Sizewell C to the atmosphere will not be monitored. This is in line with other operating nuclear power stations in the UK and wider world, and permit requirements.

It should be noted that at Sizewell C the annual dose from radioactive particulate is modelled as accounting for ≤ 0.3% of the dose from gaseous discharges. This equates to 0.012μSv/y to an adult member of the farming family. Given the low dose contribution (200,000 times less than the average annual background exposure in the UK), it would be grossly disproportionate to include particulate size modelling as part of the design of station."

We accept that the use of HEPA filters and activated charcoal filters represent BAT, will transfer airborne particulates to the solid waste stream, and that the dose impact via this pathway is low, therefore routine monitoring of particle size distributions would not be justified.

Topic: Radiological impact assessment

Raised by: ANON-CVYN-9YE8-F, ANON-CVYN-9YE8-F, ANON-CVYN-9YEP-7, ANON-CVYN-9YEQ-8, ANON-CVYN-9YEB-S, ANON-CVYN-9YEZ-H, Together Against Sizewell C, Food Standards Agency, Public Health England, ANON-CVYN-9YEV-D, ANON-CVYN-9YET-B, ANON-CVYN-9YEG-X, ANON-CVYN-9YEA-R, ANON-88ZP-DW6Y-4, Committee on Medical Aspects of Radiation in the Environment (COMARE) Authorisations Working Group (AWG)

Summary of issues raised

Consultees raised concerns about the impact of proposed radioactive discharges from Sizewell C on the local population and the surrounding protected nature and wildlife sites such as Minsmere. Specific concerns raised by consultees were the cumulative impact on people and wildlife of Sizewell C discharges in combination with those from Sizewell B, the impact on crabs and lobsters as part of local diets, the impact on bathers at local beaches, the impact on sea life and the impact of the resuspension of radioactive particles from sediment.

Some consultees stated that there is no consensus on what constitutes a safe level of radioactive emissions and that there is uncertainty around low level radiation impacts on human health. 'Together Against Sizewell C' (TASC) commented that the legislation related to radiological protection, and the science on which it is based, is flawed and urged us to engage with other government bodies concerned with radiological protection to review the underpinning science. TASC provided links to some information sources on the impact of radiation on health and requested that we ask Public Health England (now the UK Health Security Agency) to consider these information sources and provide a view on the reliability of the International Commission on Radiation Protection (ICRP) risk factors and the dose from uranium-234 used in radiological impact assessments. TASC also asked how the Environment Agency calculates the health impact of discharges, whether we calculate a range of health impacts using both ICRP/PHE recommendations as well as those from the European Commission on Radiation Risk (ECRR) and asked whether our calculations and results of expected health impacts will be made public.

The Food Standards Agency, the government body responsible for assessing the impacts of radioactivity via food pathways, responded to the consultation with the results of its risk assessment. It stated that it does not believe that the proposed limits of radioactive discharges provided in the Sizewell C application represent a significant risk to human health via the food chain.

Public Health England (PHE) responded to the consultation and made a number of comments on the radiological impact assessment NNB GenCo (SZC) provided. The majority of these comments related to the clarity of statements made in the application, but PHE also made a number of specific comments about NNB GenCo (SZC)'s sensitivity analysis presented in the assessment:

- the sensitivity analysis discusses sky shine but does not reach a conclusion about whether the conclusions of the sensitivity analysis should be applied to sky shine outputs
- given the importance of the marine food pathway, it would be expected that some of the important parameters related to marine dispersion such as volumetric exchange rates would also be considered in the sensitivity analysis. Has this been considered by NNB GenCo (SZC)?

The COMARE AWG responded to the consultation with a number of specific comments related to the radiological impact assessment undertaken by NNB GenCo (SZC). The COMARE AWG stated that:

- the dose calculations presented by NNB GenCo (SZC) use old PC-CREAM methodology and dose coefficients and that there are more recent alternatives available for modelling carbon-14
- consideration should be given to the chemical form of carbon-14 assumed for modelling discharges to atmosphere
- the radiological impact assessment should be revisited as operational experience and evidence arises from Hinkley Point C
- there did not appear to be any allowance for environmental change over the lifetime of the plant’s operation in the radiological impact assessment

The COMARE AWG also queried what the health implications of the collective dose NNB GenCo (SZC) presented would be and asked whether spatial averaging had been considered for any species included in NNB GenCo (SZC)’s non-human biota impact assessment. The COMARE AWG referenced the following paper which discusses the issues connected with spatial averaging (Smith and others, 2016).

Our consideration of the issues

Chapter 7 contains a summary of NNB GenCo (SZC)'s radiological impact assessment as well as a summary of an independent radiological assessment we have carried out, both of which consider the impact of radioactive discharges from Sizewell C on people and wildlife. We have also produced a full report of our assessment, detailing our methodology and results (Environment Agency, 2022). Our independent assessment, and that NNB

GenCo (SZC) provided, both include an assessment of the combined impact of Sizewell B and Sizewell C discharges on local residents and the protected habitats and wildlife surrounding the site.

Our independent assessment, and that NNB GenCo (SZC) provided, used local habits data collected by Cefas in 2015 to assess radiological impact. These data include information about consumption of locally caught brown crab and common lobster as well as data on time spent by members of the public bathing at local beaches. We included the transfer of radionuclides between seawater and sediment in our assessment and we consider the inhalation of sea spray as an exposure pathway. We did not consider the impact of inhalation of re-suspended sediment as a separate exposure pathway because this is captured through the assessment of inhalation of sea spray. The concentration of radionuclides in sea spray is considered to be the same as that found in the local marine compartment. The activity concentration in the local marine compartment includes the activity of suspended sediment as well as the concentration of dissolved radionuclides.

The Food Standards Agency provided a risk assessment for the safety of food that may be affected by discharges from Sizewell C. We have considered FSA's risk assessment within our consideration of radiological impact of discharges (chapter 7). We have noted PHE's comments on the radiological impact assessment NNB GenCo (SZC) provided and have taken these into consideration during our verification and validation of NNB GenCo (SZC)'s assessment. We have also factored these comments into our own independent assessment of radiological impact.

The inhalation and ingestion dose coefficients for carbon-14 used in both NNB GenCo (SZC)'s assessment and in our own independent assessment are taken from ICRP publication 119 (ICRP, 2012) which is the most recent publication of dose coefficients for use in public dose assessments. We are aware that the ICRP is in the process of updating dose coefficients to align with the updated system of radiological protection, ICRP publication 103 (ICRP, 2007), and that updated methodology and dose coefficients for occupational intakes of carbon-14 have been published.

While we await the publication of updated dose coefficients for use in public dose assessments, we consider that the use of dose coefficients taken from ICRP publication 119 is appropriate. In our assessment, we used the inhalation dose coefficient for carbon-14 associated with particulate matter. We consider this to be a conservative approach given that the carbon-14 discharges to air are expected to be a mixture of carbon dioxide and hydrocarbon gas, for which the inhalation dose coefficients for carbon-14 are lower. The updated ICRP dose coefficients, based on ICRP 103 methodology, published for workers are lower for the chemical forms of carbon-14 assumed in these radiological assessments. Therefore, we consider both our and NNB GenCo (SZC)'s assessment to be conservative in this respect.

To help answer some of the queries raised by consultees, we asked NNB GenCo (SZC) for some further information via email and telephone. A copy of the letter we sent confirming the information NNB GenCo (SZC) provided us with has been placed on the public register and has been made available on our consultation hub for the consultation on this proposed decision.

NNB GenCo (SZC) clarified that operating experience from Europe and the United States, published by IAEA, shows that the bulk of the carbon-14 in the reactor coolant is discharged in gaseous effluent. International data indicate that the airborne carbon-14 released from PWRs is predominantly hydrocarbons (75 to 95 %), mainly methane, with a smaller fraction (5 to 25%) as carbon dioxide. The UK EPR assumes 80% of carbon-14 is expected to be discharged in the form of methane. This is within the range of expected for a PWR based on published operating experience. NNB GenCo (SZC) stated that given the dose coefficients currently published by ICRP are higher for carbon dioxide than methane, the approach adopted using a number at the lower range of methane expected from a PWR is considered conservative. We also considered this issue for our own independent assessment and concluded that we would use the PC-CREAM 08 default inhalation dose coefficients, which are for carbon-14 in particulate form, as this is considered conservative.

NNB GenCo (SZC) highlighted that paragraphs 145 to 147 of Support Document D1 provide the sensitivity analysis for sky shine. Even when using an alternative and more conservative estimation methodology in which the sky shine dose is increased by 2 orders of magnitude, the largest predicted sky shine dose is still just over one-third of the reported direct dose from the current Sizewell site (10µSv/yr) and therefore very low in dose terms.

NNB GenCo (SZC) also stated that while its sensitivity analyses did not explicitly consider the marine dispersion parameters, the impacts of the volumetric exchange rate on doses were considered earlier on in the assessment (see paragraph 34 of Support Document D1). We also note in this respect that our independent assessment used refined parameter values for the local marine compartment taken from Smith (2019).

We reviewed the information sources TASC provided and wrote to PHE relaying the concerns raised about the current basis for radiological risk assessments and the use of ICRP data in principle. We note that ECRR referenced by TASC is an informal committee and does not advise the European Commission or European Parliament in any formal capacity. PHE reviewed the information provided and responded to us by letter providing a summary of its considerations. In its letter, PHE concluded that the documents referred to do not provide any additional evidence that would require changes to our radiological dose assessment methodology, which is based on the recommendations of the ICRP. A copy of our letter to PHE and its response have been placed on the public register and are available alongside these consultation documents on our consultation hub. We have considered the response from PHE along with the information provided and agree that it remains appropriate for us to use the ICRP framework as the basis for our radiological impact assessments.

In both our assessment and the one NNB GenCo (SZC) provided, the main consideration of environmental change was given to the possibility of dairy farming in the Sizewell area as there is no dairy farming reported in the 2015 Cefas habits survey. The radiological impact of this change is considered in both assessments. Habits surveys are repeated on around a 5-yearly basis. We will consider any impacts changes in habits may have on the radiological impact of discharges as more up-to-date information becomes available.

We have a legal duty to keep permits under review. Once sufficient operational experience of discharges from UK EPRs™ becomes available, a permit review will be carried out. Any future radiological assessment would take into account any changes to dose coefficients recommended by the UK Health Security Agency (formerly Public Health England) and should reflect the ICRP recommendations current at the time and specifically capture any changes to carbon-14 dose coefficients. During future permit reviews, we would also expect the operator to consider environmental change and whether this might affect the radiological impact of the discharges on people and wildlife, for example, changes to land use surrounding the site and potential exposure pathways.

In our guidance Principles for the assessment of prospective public doses arising from authorised discharges of radioactive waste to the environment (Environment Agency and others, 2012), we describe how we use collective dose to assess different process or discharge/disposal options (for example, for the abatement of discharges) rather than using it as means to calculate health implications to a population. Collective dose to the UK, Europe and world populations have been estimated for the proposed Sizewell C atmospheric and liquid discharges and are summarised in Table 7.12 in section 7.1.2. As the average annual dose for a population group is very low (in the nano Sievert range), the collective dose does not need to be considered further in the decision-making process. There are no legal limits for collective doses.

The issue of spatial averaging raised by the COMARE Authorisations Working Group relates to whether or not the home range of the wildlife species included in the assessment and the distribution of radioactivity over that area had been considered. A home range is the area in which a species lives and moves on a periodic basis. NNB GenCo (SZC) stated that no consideration had been made to the spatial scales of wildlife populations in its non-human biota assessment. We considered this issue for our own assessment but did not carry out any specific assessment of spatial averaging. In our assessment, we cautiously assumed that all reference organisms spend 100% of their time at locations where environmental activity concentrations would be at their highest. The environmental activity concentrations would be lower if averaged over a larger area, therefore we can infer that the radiological impact at other locations within a species' home range would be lower than locations we assessed. The dose rates calculated in our assessment are significantly lower than our 40μGy/h threshold, below which we have previously concluded that there will be no adverse impact on wildlife. We therefore consider that no significant proportion of any wildlife populations would be impacted.

Topic: Matters outside the Environment Agency's permitting remit

Wider environmental concerns

Raised by: Together Against Sizewell C, ANON-CVYN-9YE8-F, ANON-88ZP-DW6Y-4, Historic England, East Suffolk Council Environmental Health

Summary of issues raised

A number of consultees raised concerns over the destruction and deterioration of natural habitats and protected sites during the development of the proposed power station.

In its response to our consultation 'Together Against Sizewell C' asked what yardsticks the Environment Agency uses in terms of tonnage of fish killed, acres of AONB destroyed, hours a day of noise and dust created and potential impacts from coastal erosion before it would advise government that the development should be halted.

Consultees also queried when the Environment Agency would be consulting on other public interest environmental issues related to Sizewell C and what they will be. Issues of concern listed by the consultee included impact on fish stocks from water intake, loss of land and trees, infringement on AONB and SSSIs, impact on flora and fauna, footpath loss and reduction in access to countryside, noise, light and dust pollution, particulate and CO_2 increase from traffic, increased traffic during construction, assessment of the complete cradle to cradle lifecycle carbon footprint of the entire development, including all new infrastructure, risk of pollutants entering pristine wildlife habitats, impact on water levels in the marshes and watercourses surrounding the site and potable water demand.

East Suffolk Council Environmental Health and Historic England responded to the consultation to state that it would raise any concerns through the ongoing Development Consent Order (DCO) process.

Our consideration of the issues

Many of the concerns and issues raised relate to matters which are subject to their own separate regulatory processes, some of which we regulate, while some are regulated by other organisations.

As outlined in chapter 3, we are currently carrying out determination processes for NNB GenCo (SZC)'s water discharge activity and combustion activity applications for the Sizewell C site. These are subject to their own separate regulatory tests of acceptability and the combined impacts of all 3 operational permits are considered in our Habitat Regulations Assessment (HRA) that accompanies this proposed decision document and which can be found on our proposed decision consultation pages. NNB GenCo (SZC) would apply for further permits and licences from us in future for the construction phase of the station. These will be determined on a case by case basis within the relevant regulatory regime.

NNB GenCo (SZC) has made an application for a Development Consent Order that, at the time of writing, is being considered by the Planning Inspectorate. NNB GenCo (SZC) has a dedicated website that provides information on its application and the DCO process, as well as the DCO application documents. The DCO process considers a wide range of environmental issues associated with the Sizewell C site and its related developments, including the types of issues raised by consultees. The Planning Inspectorate also has its own portal for documents and information related to this process.

Use of nuclear power

Raised by: ANON-CVYN-9YEG-X, ANON-CVYN-9YEQ-8, ANON-88ZP-DW6C-E

Summary of issues raised

A number of consultees responded to state that nuclear power was not an appropriate technology choice for energy generation. One consultee commented that they did not see anything wrong with having Sizewell C as an available source of energy generation.

Our consideration of the issues

Energy policy, including the use of nuclear power is a matter for government. Government published an Energy White Paper: Powering our Net Zero Future on Energy in 2020 that set out the need for nuclear power, among other measures, to achieve net zero by 2050. In 2022 the Government also published the British Energy Security Strategy that states an aim that by 2050, up to a quarter of the power consumed in Great Britain is from nuclear.

Location of the regulated facility and impact on tourism

Raised by: Suffolk Coastal Friends of the Earth, ANON-CVYN-9YE2-9

Summary of issued raised

Consultees commented that they would no longer visit the area if the proposed development were to go ahead and requested that the Environment Agency consider the impact of the project on the local tourism and hospitality industry. Suffolk Coastal Friends of the Earth stated that a condition should be included in the permit that the local community should be compensated for high level waste being stored in close proximity to local villages and towns.

Our consideration of the issues

Decisions about land use are matters for the land-use planning system. In the present case, there is a DCO process taking place. The location of the facility is a relevant consideration for environmental permitting under the EPR 2016 in relation to its potential to have an adverse environmental impact on members of the public or sensitive environmental receptors. The impact on members of the public and the environment has been assessed as part of the determination process and is reported upon in chapter 7. Our consideration of a range of other legal powers and duties, which are not specific to permitting of radioactive substances activities, is set out in chapter 8.

Flood risk

Raised by: ANON-CVYN-9YEF-W, ANON-CVYN-9YES-A, ANON-CVYN-9YEF-W, Committee on Medical Aspects of Radiation in the Environment (COMARE) Authorisations Working Group (AWG)

Summary of issued raised

A number of consultees, including the COMARE AWG, raised concerns about the flood risk of the site, particularly in relation to coastal erosion and sea level rise. Consultees raised concerns about the suitability of the site given the potential impacts of climate change on the Sizewell coastline.

Our consideration of the issues

We have provided advice and guidance on flood risk in our consultation response relating to NNB GenCo (SZC)'s application to the planning inspectorate for a Development Consent Order. Our advice on these matters is normally accepted by both the applicant and the planning authority. The Office for Nuclear Regulation considers flood risk as part of its regulation of nuclear licensed sites. Flood risk and other external hazards would be addressed as part of the safety case for the site developed by NNB GenCo (SZC). NNB GenCo (SZC) has applied to ONR for a nuclear site licence.

Appendix 2- GDA Assessment Findings

We listed 18 Assessment Findings in our 2011 decision document on the UK EPR^{TM} GDA. In 2012, we identified 7 additional Assessment Findings following our assessment of the GDA Issues outstanding when the 2011 decision document was published. The full list of Assessment Findings is shown here alongside how they will be addressed at Sizewell C.

UK EPR-AF01 - The future operator shall, at the detailed design stage, identify any changes to the 'reference case' for solid radioactive waste and spent fuel strategy, and provide evidence that the site-specific integrated waste strategy (IWS) achieves the same objectives.

NNB GenCo (SZC) has provided a site-specific IWS as part of its application which partially addresses this finding. NNB GenCo (SZC) has made a commitment (Commitment 9 of the Forward Work Plan supplied with the application) to develop its IWS, in particular to include non-radioactive wastes. This required development of the IWS will be addressed though Commitment 9 made by NNB GenCo (SZC) in its application.

UK EPR-AF02 - The future operator shall, at the detailed design stage, provide an updated decommissioning strategy and decommissioning plan.

NNB GenCo (SZC) has made a commitment (Commitment 10 of the Forward Work Plan supplied with the application) to develop its decommissioning arrangements. We will work with ONR and BEIS to consider the Decommissioning and Waste Management Plan when submitted to ensure it is capable of being carried out in a way that is consistent with our regulatory requirements and expectations. This finding will be further addressed by draft permit condition 1.1.3.

UK EPR-AF03 - Future operators shall keep the removal of secondary neutron sources (to further minimise creation of tritium) under review. EDF and AREVA should provide future operators with relevant EPR operational information when available to facilitate their reviews of best available techniques (BAT).

This would be addressed through IC 3 in the draft permit.

UK EPR-AF04 - Future operators shall, during the detailed design phase for each new build project, review BAT on minimising the production of activated corrosion products for the following matters, where possible improvements were identified in the PCER:

- **(i) corrosion resistance of steam generator tubes**
- **(ii) electro-polishing of steam generator channel heads**
- **(iii) specification of lower cobalt content reactor system construction materials**
- **(iv) further reducing use of Stellites^{TM} in reactor components, in particular the coolant pump**

Where appropriate, any improvements considered BAT should be incorporated into the new build.

Further work to review minimisation of activated corrosion products for the UK EPR has been carried out by NNB GenCo (HPC). NNB GenCo (SZC) has provided this information on application of BAT to minimise corrosion products in the Environment Case, section 6.1.4, which addresses this finding for the current design phase. We consider that focus on minimising production of activated corrosion products should continue throughout the procurement, commissioning and construction phases of the development which would be addressed through IC 2 in the draft permit.

UK EPR-AF05 - Future operators shall, before the commissioning phase, provide their proposals for how they intend to implement zinc injection. The proposals shall be supported by an assessment of the impact of zinc injection on waste and crud composition.

This would be addressed through IC 13 in the draft permit.

UK EPR-AF06 - Prior to construction of the conventional and nuclear island liquid effluent discharge tank systems, future operators shall demonstrate that site-specific aspects such as size and leak-tight construction techniques are BAT.

NNB GenCo (SZC) has provided adequate information in its permit application to demonstrate that the size of the tanks is BAT, see section 6.2.11 and 6.2.12 of the Environment Case document. Information on leak tight construction techniques is not presented in the application, this aspect of the finding would be addressed through IC 21 of the draft permit.

UK EPR-AF07 - Future operators shall, before the commissioning phase, provide an assessment to demonstrate that proposed operational controls on the fuel pool are BAT to minimise the discharge of tritium to air.

This would be addressed through IC 13 in the draft permit.

UK EPR-AF08 - Future operators shall, during the detailed design phase, provide their proposals for the operational management of the liquid waste processing system to minimise the discharge of radioactivity from the site so that exposures of any member of the public and the population as a whole are kept as low as reasonably achievable (ALARA) and to protect the environment. The proposals should be supported by a BAT assessment to show that the use of the evaporator, the choice of filter porosity and the demineralisation media have been optimised to minimise the dose to members of the public. The future operator shall also provide evidence that the water treatment systems have sufficient capacity and resilience to cope with all the aqueous radioactive waste arisings consigned to the evaporator by the proposals. The proposals should consider all plant states, including, for example, outages and unavailability due to maintenance or breakdown.

NNB GenCo (HPC) has carried out further work to develop the detailed design of the liquid waste processing system. This detailed design has been adopted for Sizewell C and NNB GenCo (SZC) has stated that there are no specific factors which would mean this detailed design cannot be applied at Sizewell C. The application provides adequate information to demonstrate that the use of the evaporator, the choice of filter porosity and the demineralisation media have been optimised and that the liquid waste processing system has sufficient capacity and resilience; see sections 6.2.11 and 6.2.18 of the environment case. Any further changes to the design will be subject to the design control processes set out in the application and would be addressed through IC 2 in the draft permit.

Proposals for the operational management of the liquid waste processing system is not presented in the application. This aspect of the Assessment Finding would be addressed through IC 11 in the draft permit.

UK EPR-AF09 - Future operators shall, during the detailed design stage, provide a predicted mass balance showing how their proposed aqueous radioactive waste management regime will affect the disposal of carbon-14 to the gaseous, solid or aqueous routes. For each route, the form of carbon-14 expected shall be provided. For solid waste, the quantities of each type of waste shall be provided with expected carbon-14 content.

This will be addressed through IC 15 in the draft permit.

EPR-AF10 - The future operator shall provide confidence that adequate radioactive waste management cases (RWMCs), supported by appropriate stage Letters of Compliance (LoCs), can be developed for all intermediate level waste (ILW) on the timescales identified in EDF and AREVA's plan for disposability of ILW.

The initial work NNB (Genco) has done in relation to this is outlined in the NNB GenCo (SZC) application and is discussed in section 5.7. Future development of RWMCs and LoCs would be addressed through routine regulation.

UK EPR-AF11 - The future operator shall provide evidence during the detailed design phase that the proposed specific techniques for preventing and, where that is not possible, minimising the creation of low level waste (LLW) and ILW are BAT.

NNB GenCo (SZC) has provided adequate information in its application to address this finding.

UK EPR-AF12 - The future operator shall provide evidence during the detailed design phase that the proposed specific techniques for treating and conditioning of LLW and ILW before disposal are BAT.

This would be addressed through IC 17 in the draft permit.

UK EPR-AF13 - If smelting of any LLW is pursued, the future operator shall demonstrate that the conditions of acceptance of the selected smelting facility can be met.

This Assessment Finding will be met by NNB GenCo (SZC) complying with conditions 3.1.5 and 3.1.6 of the draft permit.

UK EPR-AF14 - If incineration of any LLW is pursued, the future operator shall demonstrate that the conditions of acceptance of the selected incineration facility can be met.

This Assessment Finding will be met by NNB GenCo (SZC) complying with conditions 3.1.5 and 3.1.6 of the draft permit.

UK EPR-AF15 - If incineration of any ILW is pursued, the future operator shall demonstrate that the conditions of acceptance of the selected incineration facility can be met.

This Assessment Finding will be met by NNB GenCo (SZC) complying with conditions 3.1.5 and 3.1.6 of the draft permit.

UK EPR-AF16 - The future operator shall, before the commissioning phase, propose techniques for the interim storage of spent fuel following a period of initial cooling in the pool. The future operator shall provide an assessment to show that the techniques proposed are BAT.

NNB GenCo SZC has provided adequate information in its application to address this finding, see section 6.1.1 of the Environment Case.

UK EPR-AF17 - The future operator shall, before the commissioning phase, provide confidence that adequate RWMCs, supported by appropriate stage LoCs and taking due account of necessary storage periods, can be developed for spent fuel on the timescales identified in EDF and AREVA's plan for disposability of spent fuel.

The work NNB (GenCo) has done in relation to this is outlined in the NNB GenCo (SZC) application and is discussed in section 5.7. Future development of RWMCs and LoCs would be addressed through routine regulation.

UK EPR-AF18 - Future operators shall provide:

a) **during the detailed design phase, the location and arrangement of sampling and continuous monitoring facilities for gaseous and aqueous waste supported by an assessment that these will provide representative sampling and monitoring**
b) **during the detailed design phase and before final equipment selection, the details of equipment and techniques to be used for analysis of gaseous, aqueous and solid waste supported by an assessment that these represent BAT for monitoring**

NNB GenCo (HPC) has carried out further work to develop the detailed design of the continuous monitoring facilities for gaseous and aqueous discharges at Hinkley Point C. This detailed design has been adopted for SZC and NNB GenCo (SZC) has stated that there are no specific factors which would mean this detailed design cannot be applied at Sizewell C. Adequate information is presented in the application to address this aspect of the finding, see section 6.5 of the Environment Case. Any further changes to the design will be subject to the design control processes set out in the application and would be addressed through IC 2 in the draft permit.

Details of the equipment and techniques to be used for analysis of gaseous, aqueous and solid waste are not provided in the application. This aspect of the Assessment Finding would be addressed through ICs 5, 6 and 7 in the draft permit.

UK EPR-AF19 - Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CI-04) used to qualify SMART devices for nuclear safety functions, has been applied to relevant SMART devices that provide an environmental protection function.

The detailed design of the systems to be used at Sizewell C are being carried out as part of the Hinkley Point C development. The use of SMART devices is addressed in IC 2 of the Hinkley Point C permit. IC 2 of the Sizewell C draft permit would address this issue where the design at Sizewell C differs from Hinkley Point C.

UK EPR-AF20 - When undertaking detailed design of structures, systems and components (SSCs) that deliver an environmental protection function, future operators shall provide evidence that demonstrates the allocation of actions between humans and technology has been substantiated and dependence on human action to maintain a benign state has been optimised.

The detailed design of the systems to be used at Sizewell C is being carried out as part of the Hinkley Point C development. The evidence that structures, systems and components devices will provide the desired environmental protection function is addressed in IC 2 of the Hinkley Point C permit. IC 2 of the Sizewell C draft permit would address this issue where the design at Sizewell C differs from Hinkley Point C.

UK EPR-AF21 - Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CC-01) used for categorising safety function and classifying structures, systems and components (SSCs) has been applied to relevant SSCs that deliver an environmental protection function.

NNB GenCo (SZC) has adopted the system developed at Hinkley Point C for the categorisation and classification of SSCs that provide an environmental protection function. This is in the form of the Environmental Protection Function (EPF) register described in the Environment Case document in the application. NNB GenCo (SZC) is adopting the Hinkley Point C EPF Register to create a Sizewell C specific Register, taking into consideration site-specific modifications.

The following are joint Assessment Findings with ONR. We have retained ONR’s numbering system for consistency.

AF-UKEPR-CC-08 - A future licensee shall use relevant arrangements under the licence and environmental permits to ensure that an independent technical review is

completed on the design changes described in Change Management Forms 24, 26 and 31 and listed in the GDA Reference Design Configuration UKEPR-I-002 Rev.15.

The UK EPR^{TM} reference design configuration adopted by NNB GenCo (SZC) and presented in the application is more developed than GDA Reference Design Configuration UK EPR-I-002 Rev. 15. The requirement for independent technical review of further design changes remains and would be addressed through IC 2 in the draft permit.

AF-UKEPR-CC-09 - A future licensee shall use relevant arrangements under the licence and environmental permits to demonstrate that the impact of design changes raised after 31 May 2012 and included in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15 are As Low As Reasonably Practicable (ALARP) /Best Available Techniques (BAT), and confirm their categorisation in terms of significance to nuclear safety and environment prior to their implementation into the site-specific detailed UK EPR^{TM} design.

The UK EPR^{TM} reference design configuration adopted by NNB GenCo (SZC) and presented in the application is more developed than GDA Reference Design Configuration UK EPR-I-002 Rev. 15. The requirement to use best available techniques (BAT) and categorise further design changes in terms of significance to the environment remains and would be addressed through IC 2 in the draft permit.

AF-UKEPR-CC-10 - A future licensee shall ensure that the development of the site-specific detail of the UK EPR^{TM} design from the GDA UK EPR^{TM} design, including work that is undertaken by vendors/contractors, is carried out under relevant arrangements as required by the licence and environmental permits.

The UK EPR^{TM} reference design configuration adopted by NNB GenCo (SZC) and presented in the application is more developed than that assessed during GDA. The requirement to develop the site-specific detail of the design under relevant arrangements remains and would be addressed through IC 2 in the draft permit.

AF-UKEPR-CC-11 - A future licensee shall use relevant arrangements under the licence and environmental permits for implementing the design changes listed in the GDA Reference Design Configuration UK EPR-I-002 Rev. 15 and described in the design change handover package documentation (see UKEPR-0020-001 Issue 01).

The UK EPR^{TM} reference design configuration adopted by NNB GenCo (SZC) and presented in the application is more developed than GDA Reference Design Configuration UK EPR-I-002. The requirement to use relevant arrangements under the environmental permit for implementing further design changes remains and would be addressed through IC 2 in the draft permit.

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