Environment Agency

Assessing new nuclear power station designs

Generic design assessment of the UK HPR1000 design

Decision document

10 January 2022

Version 1

We are the Environment Agency. We protect and improve the environment.

We help people and wildlife adapt to climate change and reduce its impacts, including flooding, drought, sea level rise and coastal erosion.

We improve the quality of our water, land and air by tackling pollution. We work with businesses to help them comply with environmental regulations. A healthy and diverse environment enhances people's lives and contributes to economic growth.

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.

Published by:

Environment Agency
Horizon House, Deanery Road,
Bristol BS1 5AH

www.gov.uk/environment-agency

© Environment Agency 2022

All rights reserved. This document may be reproduced with prior permission of the Environment Agency.

Further copies of this report are available from our publications catalogue: www.gov.uk/government/publications or our National Customer Contact Centre: 03708 506 506

Email: enquiries@environment-agency.gov.uk

Foreword

The Environment Agency is the environmental regulator for nuclear sites in England. Our regulation is independent of government and industry and is a key part of how we will deliver the long-term goals that we set out in our five year plan, EA2025 – Our Priorities to 2025. Our goals, to help create a better place for people and wildlife, are:

- a nation resilient to climate change
- healthy air, land and water
- green growth and a sustainable future

These goals are increasingly important in responding to the climate emergency and as we continue our recovery from the impacts of coronavirus.

I am pleased to introduce this document that sets out the Environment Agency's conclusions and decisions from our Generic Design Assessment (GDA) of the UK Hualong Pressurised water Reactor (UK HPR1000). The UK HPR1000 is based on the Hualong One design which is currently being constructed and commissioned by the China General Nuclear Corporation (CGN) at its Fangchenggang site in China.

The GDA process is an important part of our regulatory approach for new nuclear power stations which we developed jointly with the Office of Nuclear Regulation, the UK regulator for safety and security at nuclear sites. GDA helps us:

- have early influence on proposed new nuclear power station designs to help ensure that they meet our regulatory requirements and expectations. Influence early in the design process is when it is most effective and efficient to implement changes.
- provide potential developers and investors in any new nuclear stations with our views about the designs, so reducing the associated regulatory risks.
- carry out an open and transparent process of assessment, subject to the usual national and commercial security constraints.
- ensure that regulators work together to deliver their regulation effectively and efficiently so that the best outcome overall is secured and developers are clear what is being required of them.

Publishing this decision document completes this GDA of the UK HPR1000 with the issue of a Statement of Design Acceptability (SoDA) to the requesting party comprising CGN, Électricité de France S.A. and General Nuclear International Limited. General Nuclear System Ltd (GNSL) has been representing the three companies for this GDA.

This document explains the reasons for our decision and provides responses to the matters that were raised when we consulted on the preliminary findings of our assessment. We are grateful for all who took the time to attend our on-line consultation events and to provide us with responses. In making our decision, we have carefully considered all of the comments that we have received.

We are completing this GDA consistent with the 60 month work programme that we set with GNSL 5 years ago in January 2017. This is a considerable achievement given the

difficulties created by the Covid-19 pandemic. My thanks go to our and ONR's staff for their hard work, enthusiasm and dedication over this period of assessment. I also thank the staff of the requesting party and GNSL for how they have responded to our many questions and challenges and for coming to understand our regulatory expectations and culture in the UK. It is all of this effort that has enabled us to come to the view that the UK HP1000 is suitable for construction in England.

Bradwell Power Generation Ltd is developing proposals for the deployment of twin UK HPR1000 reactors at the Bradwell site in Essex. It will still need to obtain all of the necessary site-specific permissions required for that development to proceed. We would use all of the work we have done in GDA to help inform our site-specific assessments if applications are made for that site.

John Curtin

Executive Director of Local Operations,

Environment Agency.

Executive summary

About generic design assessment (GDA)

The UK government's energy policy set out in its recent Net Zero Energy White Paper (BEIS, 2020) and the Prime Minister's 10 point plan identify that nuclear power could play a vital role, alongside other low carbon energy sources, such as wind and solar power, in making sure that the UK has enough low-carbon electricity in the future.

As regulators of the nuclear industry, the Environment Agency and the Office for Nuclear Regulation (ONR), are working together to make sure that any new nuclear power stations built in the UK meet high standards of safety, security and environmental protection.

The regulators have developed an assessment process - generic design assessment (GDA), which enables us to begin scrutinising the acceptability of new nuclear power station designs at an early stage, in advance of any potential construction. For the Environment Agency, it means we can identify early any potential design or technical issues or concerns relating to environmental protection or performance matters that we are responsible for regulating. We can then ask the 'Requesting Party' (RP) (the organisation submitting the design for GDA) to address and resolve these issues. Similarly, for ONR, GDA means that it can identify issues and concerns relating to the safety and security of a design for the Requesting Party to address and resolve.

We carry out the GDA process in 3 stages: preparation, initial assessment and detailed assessment, more detail about the assessment stages can be found in section 2.4.

There are 3 possible outcomes for a GDA.

1. If we are fully content with the environmental aspects of the design, we provide the Requesting Party with a statement of design acceptability (SoDA).
2. If we are largely content with the environmental aspects of the design, but we have identified outstanding issues, we will provide the Requesting Party with an interim statement of design acceptability (iSoDA) that specifies the outstanding GDA Issues. We will only do this if the Requesting Party is able to provide a credible resolution plan that identifies how it will address each of the GDA Issues. A full SoDA may replace an iSoDA once we are content that all the GDA Issues have been resolved by the requesting party.
3. If we are not content with the environmental aspects of the design, we do not provide a SoDA or an iSODA to the Requesting Party.

Where we issue a SoDA or an iSoDA, we may also identify 'Assessment Findings' for developers/operators to resolve at a later stage, for example, during procurement or commissioning or initial operation.

- A GDA Issue is an unresolved issue that is significant, but resolvable, and which needs resolving before construction of the reactor starts. The Requesting Party

must publish a ‘resolution plan’ setting out how it will address the issue. All GDA Issues must be resolved to the regulators’ satisfaction before GDA can be completed.

- An Assessment Finding is an unresolved matter that is not considered critical to the decision to start construction and can only or is best resolved after GDA - it would need to be addressed during the design, procurement, construction, commissioning, or initial operation phase of the new build project.

About GDA for the UK HPR1000 design

The Requesting Party (RP) for this GDA is constituted jointly by China General Nuclear Power Co (CGN), Électricité de France S.A. (EDF S.A.) and General Nuclear International Limited (GNI). General Nuclear System Limited (GNSL) is appointed by the above shareholders to act on behalf of the RP

The Requesting Party submitted its UK HPR1000 design for GDA in January 2017. It published the submission on its website and invited people to comment on it. The Requesting Party has revised the submission during GDA; the current version on the website is up to date and is the basis of our detailed assessment.

We completed our initial assessment of the UK HPR1000 and published our initial assessment report in November 2018.

We carried out our detailed assessment of the UK HPR1000 and consulted on our preliminary conclusions for 12 weeks, from 11 January to 4 April 2021, as set out in our consultation document (Environment Agency, 2021a).

We have carefully considered all of the responses we received to our consultation and we have continued our assessment work as the Requesting Party addressed the remaining technical issues. We have now completed this assessment.

This decision document summarises the final conclusions of our detailed assessment of the UK HPR1000 design and explains why we have issued a statement of design acceptability (SoDA).

We have worked closely with ONR throughout our assessment, and our publication of this decision document aligns with ONR concluding its Step 4 design assessment and its decision to issue a design acceptance confirmation (DAC).

Our decision

Following our detailed assessment, our conclusion is that we can issue a SoDA for the UK HPR1000 and this is included as Appendix 1. This statement is provided as advice to the Requesting Party, under Section 37 of the Environment Act 1995. It does not guarantee that any site-specific applications for environmental permits for the UK HPR1000 will be successful.

In reaching our decision, we have identified 45 Assessment Findings. These Assessment Findings are collated in Appendix 2, but should be read with the supporting information presented in our assessment reports to provide context. We expect future operators to address the Assessment Findings during the appropriate detailed design, procurement, construction or commissioning phase of any new build project.

ONR's GDA Step 4 assessment has also concluded and it has made a recommendation to issue a design acceptance confirmation (DAC).

What happens next?

Now that we have issued a SoDA, if we receive applications for environmental permits for specific sites, we expect the applications to be based on the GDA submissions. In determining these site-specific applications, we would take full account of the work we have done during GDA, so that our efforts can be focused on operator and site-specific matters, including how the operator has addressed, or intends to address, the Assessment Findings. We would carry out further public consultation before deciding whether or not to issue operational permits for a specific site.

Contents

1. About this decision document

The purpose of this document is to explain our generic design assessment (GDA) decision, following assessment and consultation on the acceptability of a new nuclear power station design, the UK Hualong pressurised water reactor (UK HPR1000) submitted by General Nuclear System Limited.

The Requesting Party (RP) for this GDA is constituted jointly by China General Nuclear Power Co (CGN), Électricité de France S.A. (EDF S.A.) and General Nuclear International Limited (GNI). General Nuclear System Limited (GNSL) is appointed by the above shareholders to act on behalf of the RP.

Our assessment and our decision is about the environmental aspects of the proposed design based on a generic site specified by the requesting party. It is not about its deployment at a specific site. It is also not about the need for nuclear power or the siting of nuclear power stations.

The Office for Nuclear Regulation (ONR) has also assessed the UK HPR1000 from a safety and security viewpoint. Although we work closely with ONR, this decision document is only about the Environment Agency's assessment. Where consultation responses were raised relating to safety or security issues, we have passed them on to ONR for it to consider.

This document provides:

- an introduction to our role in nuclear regulation and the basis for generic design assessment (GDA) (Chapter 2)
- an outline of the UK HPR1000 design (Chapter 3)
- a guide to our detailed assessment (Chapter 4)
- our detailed assessment (Chapters 5 to 17)
- our overall conclusion (Chapter 18)
- appendices supporting the decision document (Appendices 1 to 12)

The detailed assessment provided in Chapters 5 to 17 are summaries of the information available in our detailed assessment reports, which have been updated after our consultation, where appropriate, to reflect:

- our assessment of any further information, if provided by the RP, since the consultation
- the further work that we said, in the consultation document, that we intended to do
- matters arising from ONR’s GDA Step 4 work that are relevant to our assessment
- any change in our approach or conclusions arising from our consideration of relevant consultation responses
- any change in our approach or conclusions arising from our consideration of comments received on the RP's website, and the RP's responses

The questions we asked as part of our consultation are listed in Appendix 5. All the consultation responses we received are listed in Appendix 6.

Where a response and our reply relate to a matter in scope of GDA, we have captured these in Appendix 7.2. A number of responses did not directly concern GDA and these are summarised in Appendix 7.3. Responses outside of our regulatory remit are listed in Appendix 7.4. These were passed to the relevant organisation for it to consider.

Our GDA assessment is based on a single reactor unit deployed on a generic site.

To undertake a GDA, we have to make some fundamental assumptions which are shaped by current government policy. These are that:

- the government will provide a geological disposal facility (GDF) for disposal of higher activity wastes, in line with its current policy
- spent fuel will not be reprocessed, but will be sent for disposal at a GDF at the appropriate time
- regulation will continue for the full life cycle of the plant until the site is released from regulatory control through surrender of the environmental permit

2. Introduction

This chapter describes the Environment Agency's role in nuclear regulation, the development of new nuclear power stations, and how we carry out GDA.

2.1. Government policy on nuclear new build - the origins of GDA

Government is responsible for the UK's energy policy and it set out its current position in the December 2020 white paper, 'Powering our Net Zero Future' (BEIS, 2020). In the white paper, the government highlights the need to address climate change urgently. It sets out its strategy for wider energy systems to achieve the UK's target of net zero greenhouse gas emissions by 2050. The strategy includes a continuing and future role for nuclear generation to provide reliable, clean electricity. It also sees a potential additional role for advanced modular reactors (AMR) to provide high temperature process heat in the future. Government's position is that additional new nuclear power stations are required and it intends to bring at least one further large-scale nuclear power station to a final investment decision by the end of the current parliament. It is proposing to invest in the development of a UK designed small modular reactor (SMR) and open up generic design assessment to SMR technologies. It also commits to research and development funding for AMR and to continue to develop fusion energy.

The nuclear regulators, the Environment Agency and the Office for Nuclear Regulation (ONR) developed the generic design assessment process at the request of government to enable early assessment of safety, security and environment protection aspects of new reactor designs at a generic level, before receiving an application to consider a particular nuclear power station design at a specific location. Access to generic design assessment is controlled by government because the selection of which reactor designs should be assessed is primarily a UK strategic or commercial consideration or both.

2.2. Our role in regulation

The Environment Agency regulates the environmental protection aspects of nuclear sites in England such as nuclear power stations, nuclear fuel production plants, and plants for reprocessing spent nuclear fuel. We do this through a range of environmental permits. These permits may be needed for one or more of the site preparation, construction, operation and decommissioning phases within the plant's life cycle.

The permits we issue can include conditions and limits. In setting these, we take into account all relevant national and international standards, and UK legal and policy requirements, to ensure that people and the environment will be properly protected. These standards and requirements are described in government and Environment Agency guidance available at:

Radioactive substances regulation for nuclear sites

Radioactive and nuclear substances and waste

We inspect sites to check that the operator is complying with the conditions and limits, and that it has arrangements in place to ensure and demonstrate compliance. We may take enforcement action, for example, issuing an enforcement notice or taking a prosecution if it is not complying with permit conditions.

We regularly review permits, and vary (change) them if necessary, to ensure that the conditions and limits remain effective and appropriate and that people and the environment continue to be properly protected.

We work closely with ONR, which regulates the safety and security aspects of nuclear sites.

2.3. Our regulatory role in the development of new nuclear power stations

As for existing nuclear sites, any new nuclear power station will require environmental permits from us to cover various aspects of site preparation, construction, operation and eventually decommissioning. In the light of government and industry expectation that power stations of almost the same design might be built on a number of sites and potentially be run by different operating companies, we have split our process for assessing and permitting the operational stage of new nuclear power stations into 2 phases.

2.3.1. First phase: Generic design assessment

In the first phase, generic design assessment, we carry out assessments of candidate designs. We provide an assessment which sets out our findings about the acceptability of the design. There may be GDA Issues and Assessment Findings associated with our assessment. For the UK HPR1000, we are closing this phase with this decision document.

- A **GDA Issue** is an unresolved issue considered by regulators (ourselves or ONR) to be significant, but resolvable, and which needs resolving before nuclear island safety-related construction of the reactor could be considered.
- An **Assessment Finding** is an unresolved issue of lesser significance, not considered critical to the decision to start nuclear island safety-related construction. In many cases, resolving the issue will rely on one or more of the following:
    - site-specific information
    - operator design choices
    - operator-specific features, aspects or choices
    - operator choices on organisational matters
    - the plant being at some stage of construction or commissioning or initial operation
    - the level of detail of the design being beyond what can reasonably be expected in GDA (for example, manufacturer or supplier input is required, or where the technology changes quickly such that early choices could lead to the design becoming obsolete)

An Assessment Finding will need to be addressed, as part of our normal regulatory process, by a future operator during the detailed design, procurement, construction or commissioning phase of the new build project. We may include Assessment Findings in site-specific permits, if issued, by means of pre-operational conditions or requirements.

During GDA, we work closely with ONR to assess areas where we have complementary regulatory responsibility, including radioactive waste and spent fuel management, and management arrangements for controlling design changes and GDA submission documents. We have established a Joint Programme Office (JPO), which administers the GDA process on behalf of the regulators.

Further information on the GDA process can be found in section 2.4.

2.3.2. Second phase: Site-specific

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, including how the operator has addressed any outstanding GDA Issues (where there is overlap between a site-specific application and completion of GDA) or Assessment Findings. We also carry out further public consultation before deciding whether or not to issue operational permits for a specific site, and if so, the conditions that it should include.

2.3.3. Our input to the government's facilitative actions on nuclear new build

In addition to our regulatory role, we have provided specialist advice, where appropriate, and responded to consultations relating to the actions taken by government to:

- reduce the regulatory and planning risks associated with investing in new nuclear power stations
- ensure operators of new nuclear power stations set aside funds to cover the costs of decommissioning and long-term waste management and disposal

These include:

- Strategic siting assessment - this work identified those sites that are strategically suitable for the deployment of new nuclear power stations by the end of 2025. The selected sites are listed in the 'National policy statement for nuclear power generation: EN-6' ('NPS EN-6') (DECC, 2011b and 2011c). This provides the framework for decisions on planning consent (Development Consent Orders). These decisions are taken by the Secretary of State for the Department for Business, Energy and Industrial Strategy (BEIS) based on recommendations made by the Planning Inspectorate.
- Justification - before any new type of nuclear power station can be built in the UK, it must be 'justified', that is, it must be shown that the net benefits outweigh any detriments to health. The Department for Environment, Food and Rural Affairs (Defra) will be acting as the Justifying Authority and it will begin considering Regulatory Justification for the UK HPR1000 if an application is made.

- Funded decommissioning programme - 'The Energy Act 2008' (UK Parliament, 2008) requires any operator of a new nuclear power station to have a funded decommissioning programme, approved by the Secretary of State, in place before construction begins, and to comply with this programme. The government published funded decommissioning programme guidance in December 2011 (DECC, 2011d).

2.4. About generic design assessment

GDA means that we assess the acceptability of the environmental aspects of an overall reactor design before individual site applications are made. GDA allows us to get involved with designers and potential operators of new nuclear power stations at the earliest stage, where we can have most influence and where lessons can be learned before construction begins. This early involvement also means that designers and potential operators can better understand the regulatory requirements before they make significant investment decisions.

2.4.1. GDA process

The GDA for the UK HPR1000 has been carried out under GDA guidance published in 2016, the Process and Information Document (P&ID) (Environment Agency, 2016). We published new guidance, GDA guidance for Requesting Parties, in 2019 which will apply to any new request for a GDA (Environment Agency, 2019). The updated guidance was published to allow a future Requesting Party (RP) to complete the GDA process in stages or to complete a partial GDA. The GDA was modernised after a decade of regulatory experience to optimise the process and to take into account lessons learned. The scope and requirements for a full GDA in the new process remain the same as in the original P&ID.

Our P&ID sets out in detail the information that we require and the process that we follow during GDA of the UK HPR1000. Our process, as outlined in the P&ID, has 6 main elements, with a seventh element to be used when we issue an interim statement of design acceptability (iSoDA).

1. **Initiation (GDA Step 1)** - a request comes from government to the Environment Agency asking us to carry out a GDA on a specific design. We establish a **Section 37** agreement (Environment Act 1995) with the RP that enables us to recover our costs for GDA. We work with the RP and ONR to agree a programme and project management arrangements for the GDA submission.
2. **Initial assessment (GDA Step 2)** - we carry out a high-level assessment of the submission made by the RP, specifically looking for significant issues with the design or any matters that are obviously unacceptable. We also identify any necessary information missing from the submission. We will look in more detail at:
    - the RP's management arrangements for carrying out the GDA
    - the definition of the generic site, to ensure appropriate reflection of potential UK sites
    - the potential impact of the proposed discharges, to give early assurance that UK limits and constraints will be complied with

3. **Detailed assessment (GDA Step 3)** - we carry out a detailed assessment of the submission, examining claims and arguments made and the evidence that supports them. We will come to a preliminary view on whether:
    - we might issue a statement of design acceptability (SoDA)
    - we might issue an interim statement of design acceptability (iSoDA) with associated GDA Issues
    - the design is unsuitable and we will not issue a statement
4. **Consultation** - we consult widely on our preliminary view following detailed assessment. We provide a consultation document explaining the reasons for our preliminary view. We also publish our more detailed technical assessment reports to help inform the consultation.
5. **Post consultation review** - we carefully consider all relevant responses to the consultation and update our assessments where necessary. Where responses lie outside our responsibilities, we pass them to the appropriate regulator, government body or public body for consideration.
6. **Make a decision** - we decide whether to issue a SoDA or iSoDA or neither. We publish a decision document explaining the reasons for our decision and our updated technical assessment reports.
7. **Resolving GDA Issues** - we assess the further information provided by the RP to clear the GDA Issues associated with an iSoDA and, if satisfied, issue a full SoDA.

For both initial and detailed assessment, we use a tiered approach for raising concerns or requesting further information that depends on the level of our concern.

- **Regulatory Query (RQ)** - this is a request for clarification or further information and does not necessarily indicate any perceived shortfall in the design.
- **Regulatory Observation (RO)** - we raise an RO when we identify a potential shortfall that requires action and new work for it to be addressed. Each RO can have several associated actions.
- **Regulatory Issue (RI)** - we raise an RI when we identify a serious shortfall that would prevent us issuing a SoDA, and that requires further work. Each RI can have several associated actions.

Both ROs and RIs are published on the Joint Regulators' website. It is possible for an RQ to escalate to an RO or RI, and for an RO to escalate to an RI.

Successfully completing GDA does not mean that construction at a site could proceed, as any future operator must still apply for and secure all relevant permissions for the site before this could begin.

2.4.2. Scope of a GDA

While the regulators require a certain minimum level of detail to complete a GDA, we recognise that full engineering details of the design may not be available at the GDA stage, as it is normal to finalise some of these as part of the procurement and construction programme.

The scope of what is included within GDA depends on the information supplied by the RP (GDA is a voluntary process). However, the information provided for GDA needs to be sufficient in scope and detail to enable a meaningful assessment of the safety, security and environmental aspects of the design. We would not be able to proceed with an assessment if substantial essential information is missing.

The scope of GDA is defined by the total amount of information provided in the submission to the regulators (as recorded in a 'master document submission list'), together with the 'design reference'. The design reference is a list of all the documents that together describe the design of the reactor and associated plant. We expect this to be 'frozen' at a specific date known as the 'design reference point'.

2.4.3. GDA outcomes

There are a number of possible outcomes for a GDA:

1. If we are fully content with the environmental aspects of the design, we provide the RP with a statement of design acceptability (SoDA). However, there may still be some Assessment Findings that a future operator will need to resolve at a later stage, for example, during procurement or commissioning. An Assessment Finding is an unresolved matter that is not considered critical to the decision to start construction and can only or is best resolved after GDA - it would need to be addressed during the design, procurement, construction, commissioning, or initial operation phase of the new build project. A decision to issue a SoDA can only be reached when we have carried out a full public consultation and carefully considered the responses we receive.
2. If we are largely content with the environmental aspects of the design, we provide the RP with an interim statement of design acceptability (iSoDA) that specifies the outstanding GDA Issues. We will only do this if the RP is able to provide a credible resolution plan that identifies how it will address each of the GDA Issues. A full SoDA may replace an iSoDA once we are content that all the GDA Issues have been resolved. A GDA Issue is an unresolved issue that is significant, but resolvable, and which needs resolving before nuclear island safety-related construction of the reactor could be considered. A decision to issue an iSoDA and then a SoDA can only be reached when we have carried out a full public consultation.
3. If we are not content with the environmental aspects of the design, we do not provide a SoDA or iSODA to the RP.

2.4.4. Regulatory basis for GDA

We provide a SoDA as advice to the RP, in accordance with Section 37 of the Environment Act 1995 (UK Parliament, 1995). It has no other formal legal status. However, we will take full account of the work that we have done during GDA if we receive applications for environmental permits relating to a design that has been through GDA.

A SoDA will, subject to the scope of the GDA and the nature of the design, state our view on the acceptability of the design to be permitted for:

- the disposal of radioactive waste (gaseous, aqueous, non-aqueous and solid), under the Environmental Permitting Regulations 2016 (EPR16) (UK Parliament, 2016)
- the discharge of aqueous effluents containing non-radioactive substances to surface waters and groundwater, under EPR16
- the operation of certain conventional plant (for example, standby generators, combustion plant used as auxiliary boilers), under EPR16
- the disposal or recovery of non-radioactive waste, under EPR16
- the abstraction of water from inland waters or groundwater, under the Water Resources Act 1991 (WRA91) (UK Parliament, 1991)

It will also state our view on the acceptability of the design with respect to the environmental requirements of the Control of Major Accident Hazards Regulations 2015 (COMAH) (UK Parliament, 2015).

Our GDA process focuses mainly on matters relevant to the disposal of radioactive waste.

This is because:

- the generation of radioactive waste is intrinsically linked to the detailed design of a nuclear reactor and its associated plant
- permitting the disposal and discharge of radioactive waste has, in the past, been the area of regulation with the longest lead time for our permitting of new nuclear power stations

We also address, as far as is practicable at a generic level, aspects of the design related to the other regulatory requirements listed above.

Completion of a GDA does not mean that an operator can build a nuclear station. A future operator would still need to apply for and obtain all relevant site permissions from the regulators and other bodies.

New nuclear power stations are likely to need new or enhanced flood defence structures that will require a flood risk activity permit under the Environmental Permitting Regulations 2016. As flood defence is necessarily site-specific, we do not consider this matter during GDA. However, flooding hazards are considered at GDA, by the Office for Nuclear Regulation, as part of its assessment of external hazards.

2.5. The GDA for UK HPR1000

2.5.1. Initiation and initial assessment

Our process and the outcome of our initial assessment of the GDA for the UK HPR1000 is described in our initial assessment statement of findings (Environment Agency, 2018a). This is summarised below.

In our initial assessment, we examined the management systems used for producing the submission and the impact of the proposed radioactive discharges. We formed a view as

to whether the submission contained any matters that are obviously unacceptable or whether we could identify any significant design modifications that are likely to be needed. We also assessed whether there was enough information for us to carry out the detailed assessment stage.

At the initial assessment stage and based only on information we had seen up to 30 June 2018, our conclusions were that:

- we did not find any matters within the submission that were obviously unacceptable
- we did not identify any significant design modifications that were likely to be needed before we could issue a permit
- the RP has an adequate management system in place to control the content and accuracy of the information it provides for GDA for the current stage
- as calculated by the RP, the annual radiation impact of the UK HPR1000 design on people would be below the UK constraint for any single new source
- based on the information we were given it is unlikely that radioactive discharges would exceed those of comparable power stations, but the RP needs to demonstrate this for discharges and for quantities of solid waste
- the submission did not contain the level of information that we needed in order to carry out a detailed assessment

The RP committed to provide all the required information within a timescale that, subject to the quality of the information, should allow us to carry out our detailed assessment and to maintain our overall target of completing a meaningful GDA within 4 years.

These conclusions were based on our initial assessment of the information we received up to 30 June 2018 and considered any public comments received up to 31 August 2018. The initial assessment statement of findings was published on 15 November 2018.

2.5.2. Detailed assessment

We began our detailed assessment in November 2018. Where practicable at the generic level, our assessment has taken account of all relevant national and international standards, and UK legal and policy requirements, to ensure that people and the environment will be properly protected. These standards and requirements are described in government and Environment Agency guidance available at:

Radioactive substances regulation for nuclear sites

Radioactive and nuclear substances and waste

The submission

We carried out our assessment using the information the RP provided in the ‘Pre-Construction Environmental Report’ (PCER) and ‘Pre-Construction Safety Report’ (PCSR). These documents and their supporting references are collectively referred to as 'the submission'. The documents are publicly available on the RP’s website:

- PCER and PCSR version 000, issued November 2018
- PCER and PCSR version 001, issued November 2019
- PCER version 001-1 and PCSR version 1 amendment document, issued October 2020 for alignment with our consultation
- PCER and PCSR version 002, issued October 2021

Our final assessment is aligned with the information from PCER and PCSR version 002 and their supporting documents, which have been updated throughout the GDA process to align with UK regulatory expectations and final GDA design.

Scope of the UK HPR1000 GDA

The scope of the UK HPR1000 GDA is defined by the Requesting Party and includes a single reactor unit situated in a generic site, based on site parameters applicable to the UK.

The scope for the UK HPR1000 GDA (GNSL, 2019a) includes:

- all buildings that are subject to safety classification (Class 1 & 2) or are important to nuclear safety, environmental protection or security
- all systems that perform or support the following functions:
    - reactivity control
    - containment of radioactive substances
    - heat transfer or removal
    - environmental protection
    - security

Our assessment process

In our process and information document (P&ID) (Environment Agency, 2016), we set out our requirements for environmental considerations in the design of new nuclear power stations. We also published our 'Radioactive Substances Regulation Environmental Principles' (REPs) in 2010 (Environment Agency, 2010a). We have applied these requirements and principles throughout our assessment of the design.

We have examined in detail the relevant design documents that the RP has provided. Where additional detail was required in order for us to complete our assessment, we identified this and requested further information from the RP. We held technical discussions with the RP to ensure a full understanding of its design, to discuss points of clarification and to provide advice to resolve regulatory concerns.

We raised Regulatory Queries (RQs) to clarify information and Regulatory Observations (ROs) where we identified a need for additional work. We did not raise any Regulatory Issues (RIs) as no concerns of significance were identified. We have assessed the further information the RP provided since the consultation and continued dialogue where necessary to reach a clear understanding and conclusion.

We published our preliminary assessments and consulted widely. We have carefully considered all the responses to our consultation. We have also reviewed and considered comments raised via the RP public comments process and the RP's responses to those comments where relevant.

We have updated our assessment reports to take into account the above considerations and any additional information from the RP to inform our overall decision on the acceptability of the design.

Final assessment reports

We have documented our detailed assessment in a series of technical assessment reports. These are listed in Appendix 4 and summarised in Chapters 5 to 17 of this document. The final assessment reports are revisions of the documents that we published to support the consultation. The updated final assessment reports reflect:

- our assessment of further information the RP has provided since the consultation date, including information about matters that arose during consultation
- the further work that we said, in the consultation document, that we intended to do
- matters arising from ONR's GDA Step 4 work that are relevant to our assessment
- any changes arising from our consideration of relevant consultation responses
- any changes arising from our consideration of relevant comments received on the RP's website, and the RP's responses

Liaison with ONR and other bodies

We have worked closely with ONR throughout GDA. This enables us to achieve a balance between environmental and safety issues in relation to radioactive waste. We have considered its relevant assessment reports (http://www.onr.org.uk/new-reactors/uk-hpr1000/reports.htm).

2.5.3. Consultation

We aim to build and maintain confidence in our decision-making processes for GDA through our public involvement and our public consultation process.

The GDA process was designed to reflect the environmental regulators' normal processes for applications for nuclear site environmental permits. Consultation is normal practice for the Environment Agency when dealing with applications for nuclear site permits.

We consulted on our preliminary conclusions following our detailed assessment of environmental aspects of the UK HPR1000 new nuclear power station design for 12 weeks, from 11 January to 4 April 2021.

The aim of our GDA consultation is to share information with people, explain our decisions and to take into account the feedback that we receive. We have deliberately made the GDA process open, transparent and consultative and we would like people to understand our role, what we are doing and why it's important.

Our public 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.

The consultation did not relate to a specific site. However, the Bradwell B Power Company is developing proposals for 2 UK HPR1000s to be constructed at the Bradwell site in Essex, adjacent to the existing Magnox power station.

We also stated clearly that the consultation was not about the need for nuclear power, UK energy policy, policy relating to the siting of nuclear power stations, or the safety and security of the design.

It is our responsibility to make decisions about the environmental acceptability, or not, of a reactor design. We consider that our decisions are better informed through consultation. Before and during consultation we emphasised that we would not make any final decisions until we had considered all of the responses to the consultation. Our approach to consultation is in line with the government's published consultation principles. Our consultation plan was published in advance of the consultation on GOV.UK.

We received 52 responses to the consultation. We list the names of all the organisations that responded in Appendix 6 of this decision document. We have not given names of individuals or members of the public. The list gives a GDA number to each response (for example, UKHPR1000-044 is for the Food Standards Agency), so that this document and the assessment reports can be searched to allow all respondents to see where their responses have been considered.

We published a compilation of all the responses to our consultation on GOV.UK on 28 July 2021. We considered all the responses and the outcome of ONR's assessment before coming to a final decision on the acceptability of the design.

This section describes aspects of our engagement and communications throughout GDA and includes information about:

- our consultation documents
- how we promoted our consultation, kept people informed and our engagement
- the public comments process
- promoting our work about GDA to the public and interested groups
- future opportunities to get involved

Our consultation documents

We published the following documents on the GOV.UK and Citizen Space websites. We also printed copies and made them available to those who requested them.

- Technical assessment reports and an independent dose assessment (these are technical documents setting out the preliminary findings of our assessments and may need specialist knowledge to understand them).

- Consultation document and interim statement of design acceptability (iSoDA) (a compilation of technical information with summaries at the start of each chapter).
- Summary document (a short form, less technical version of the consultation document aimed at the public who have some interest in nuclear issues).
- Webpages and a leaflet (provided to assist public understanding).
- Infographics (provided to assist public understanding).

Promoting the consultation

We asked national and local stakeholders for their views on the consultation process before our consultation began. We informed them about our assessment work and asked them how they wanted to be involved in our consultation process. 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 set out our objectives for consultation in the plan. We wanted to make sure that stakeholders:

- understood how we assessed the reactor design
- understood the conclusions of our assessments and why we made our decisions
- understood how they could provide their views, what they could and couldn't comment on and how we would use their input to inform our assessment
- had many opportunities to give us their views
- helped make our final decision on the acceptability of the reactor design as robust as possible
- knew more about how GDA fits into the bigger picture of nuclear power station development
- understood each regulator's role, specifically around GDA and regulation of nuclear new build – what we do and what we don't do

We believe that the level of local and national engagement was proportionate for this generic design assessment. We are confident that we did all we reasonably could do 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 to the Bradwell 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 added links from our regulators' joint website

- provided an accessible e-consultation tool which hosted our documents and enabled an online response
- provided a plain English, high-level summary on GOV.UK. In this, we were clear about the consultation process and the scope of consultation
- printed copies of the consultation document and summary and posted them to local and national stakeholders both on request and proactively
- updated local MPs through briefings
- advertised the consultation in local print and online newspapers (Maldon and Burnham Standard, Essex County Standard, Colchester Daily Gazette, East Anglian Daily Times, Regional Life – all editions), which could be read by people living near to the Bradwell site in Essex 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, LinkedIn) to promote links to our consultation pages and online meetings
- posted and shared a blog on GOV.UK
- sent posters and GDA information leaflets to parish councils near the Bradwell site, with a request to post them on outside noticeboards and other locations that the public were able to use during coronavirus restrictions
- used infographics to explain our role and process
- 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 Bradwell B Power Generation Company Limited's newsletters which are sent to all households in the area and an email subscriber list
- provided information about the consultation to the RP and Bradwell B Power Generation Company Ltd for the companies to use in their communications to stakeholders and the public (such as the newsletter mentioned above)
- provided information to our staff closest to the site so they would be able to answer questions from the public in the area

What we did to engage directly with stakeholders during consultation:

- We organised consultation events online using Zoom and Teams. We provided speakers from the Environment Agency and Office for Nuclear Regulation, and representatives from the company with expert technical knowledge of the assessment process and nuclear power stations.
- The sessions involved presentations and provided an opportunity for attendees to ask questions and discuss the issues raised.
- The events were advertised widely on posters, in local print publications and online, and details were sent to our stakeholder database.
- Around 100 people attended the events, representing a wide range of organisations such as local and parish councils, local environment groups, industry, NGOs and some members of the public. Online engagement enabled a greater number of

participants than have attended previous GDA events in person. The main events are listed below:
    - 10 February 2021 – National stakeholders
    - 11 February 2021 – Maldon District Council
    - 17 February 2021 – Blackwater Against New Nuclear Group (BANNG) and Colchester Borough Council
    - 23 and 25 February 2021 – Local public and interested groups
    - 24 February – National nuclear NGOs
    - 26 February – West Mersea Town Council
    - 3 March – Bradwell Action Network (BAN)
- We attended meetings organised by others to provide briefings:
    - 3 March - Bradwell site stakeholder group
    - 3 February – Bradwell B Community Forum
    - 9 March – BANNG open meeting
- We highlighted the consultation to members of the BEIS NGO forum.
- We informed attendees of our bi-annual nuclear regulator local engagement meetings which we hold with stakeholders in Essex and Suffolk.
- We offered telephone appointments to those who did not want to, or couldn't participate in online events.
- We provided a postal address for those who did not want to, or couldn't use email or the e-consultation tool.
- We published notes from the engagement meetings on Citizen Space on 25 March to assist those in the final stages of completing their response.

To help promote the consultation, the RP and Bradwell B:

- voluntarily participated in Environment Agency consultation events, providing speakers and responding to questions
- provided a slot and agenda item for the Environment Agency at the 3 February Community Forum
- issued a press release at the start of consultation on 11 January
- issued a press release at the end of the consultation on 7 April
- shared information in the community newsletter sent via post and email
- shared information in the company stakeholder e-shot in January, February and April
- shared information by email with people who had taken part in the GDA comments process
- shared information on the company's social media channels

The Requesting Party public comments process

We ask all requesting parties who enter the GDA process to set up a website and publish information about its design, invite comments and questions about the design, and respond to those comments and questions.

This continuous ‘comments process’ was available to anyone throughout our assessment of the UK HPR1000 on the company’s website. The company updated information on the website throughout GDA and it contains all the information submitted to the regulators. Information which is commercially confidential or subject to national security restrictions was not placed on the website.

The public comments process opened in November 2017 and continued throughout GDA until 17 September 2021. To complete our GDA of the reactor designs by January 2022, we needed to receive any comments on the designs in sufficient time to reflect them in our decision document (and ONR’s Step 4 reports). To enable this, the comments process closed on 17 September 2021, around 4 months before we made our decision.

The RP received and responded to 73 comments. We saw the questions and the RP’s responses and used them, where relevant, to help inform our assessments. Where they relate to our areas of interest, our detailed assessment has taken account of comments received and the RP's responses to those comments submitted up to 17 September 2021.

The RP provided information about common themes from the comments on the UK HPR1000 website.

The RP and Bradwell B promoted the public comments process throughout the GDA. This included:

- awareness-raising around the launch of Step 2 with a press release and e-bulletins to local councils, councillors and stakeholders, and MPs
- featuring the comments process in presentations to industry groups, Essex business forums, the Bradwell B community forum, and wider stakeholders
- highlighting it in media announcements about the company
- advertising in local magazines such as Regional Life
- including articles in the Bradwell community newsletter
- using social media channels – Twitter and Facebook
- promoting the closure date in August 2021 with a press release, social media and ebulletin

Raising awareness of our work on GDA with the public and stakeholders

With ONR we published our approach to communications and engagement for the UK HPR100 GDA.

We have raised awareness of this GDA and the opportunity to use the public comments process throughout the GDA and after the consultation closed by:

- meeting with stakeholder groups, for example, at Bradwell B community forum and at regulator events
- sharing information by e-bulletin and at meetings with nuclear and environmental academics
- responding to enquiries from journalists for media articles

- explaining our work at national conferences and seminars
- providing accessible information on our websites
- publishing updates about our work and the status of Regulatory Observations (ROs) on the joint website
- sharing information with stakeholders through e-bulletins
- asking the RP to share information on its website, through its community newsletter and social media channels
- publishing a compilation of all the responses to our consultation on GOV.UK on 28 July 2021
- emailing our stakeholders to let them know we had published this and that they still had time to contribute via the 'comments process'

Evaluation of consultation

Evaluation enables us to learn lessons and share our experiences with others. For example, we know that approximately 60% of those who responded used our online tool. We are evaluating the effectiveness of our communications and engagement for this GDA, and will use the findings to improve our work on future GDAs and other relevant consultations that we carry out.

Future opportunities for engagement following GDA decision

If GDA is completed successfully it means that the regulators consider that a power station based on that design is capable of being built and operated at a site in England consistent with their safety, security, environment protection and waste management requirements and expectations. However, before that could happen any company that wants to build and operate a new nuclear power station at a site must apply for and obtain all relevant site-specific permissions from the nuclear regulators and other bodies. For a nuclear site, this includes planning permission in the form of a Development Consent Order. When making decisions about site-specific applications, the regulators will take account of all the work they have carried out during GDA.

The Environment Agency is responsible for issuing a range of environmental permits for constructing and operating nuclear power stations, and for relevant 'associated developments'. These permits cover activities such as disposal and discharges of radioactive waste, cooling and process water discharges, and operating back-up generators. We also issue relevant permits for site investigation and construction works such as drilling boreholes, abstracting groundwater, discharging treated effluents and the use of mobile diesel electricity generators. We will decide if the permits should be issued and, if so, what conditions should apply.

Our decision-making process for operational permit applications includes 2 periods of consultation. Firstly, we ask for comments on the permit applications. Later, we have a period of consultation when we provide a consultation document setting out our views, and we ask for comments on our proposed decision. Only after we have carefully considered the comments we receive in that consultation do we make our final decisions.

For site investigation and construction site permit applications, we also have a period of consultation on the application. Once we have carefully considered the comments we receive in that consultation we make our decision. We are mindful that construction activities are not unique to nuclear developments and are time limited, so we deal with the permit applications as we would for other construction sites. This is a proportionate approach that will help us exercise the best regulatory control on rapidly changing construction activities.

Other relevant applications that would be required include:

- Planning Inspectorate for planning permission – a Development Consent Order
- Office for Nuclear Regulation for a nuclear site licence

The Bradwell Power Generation Company Limited is currently developing plans to build a new power station based on the UK HPR1000 at Bradwell B, adjacent to the existing decommissioned Magnox nuclear power station. There will be further opportunities for engagement and input into our decision-making processes if we receive applications for environmental permits for operation of a new power station. Before we consult we will ask communities and local organisations how they would like to be involved in our decision-making.

The RP provides information about the wider context on its website.

Post consultation review

We have acknowledged all the responses, but we do not enter into further correspondence with those who responded.

We have carefully considered each response that we received. A number of responses to our consultation raised matters outside the scope of GDA and sometimes outside our regulatory remit. These comments are summarised in Appendix 7.3 and 7.4, with a short note as to why we are not considering them in our GDA. Examples include:

- site-specific concerns
- government policy or other government facilitative actions
- matters associated with planning
- matters associated with the development of a geological disposal facility (GDF)

3. The UK HPR1000 pressurised water reactor design

3.1. Outline of design

The UK HPR1000 design for GDA is a pressurised water reactor (PWR) capable of generating 1,180 megawatts (MW) of electricity. Further detail on the design can be found in chapter 2 of the Pre-Construction Safety Report (PCSR), which can be found on the UK HPR1000 website. A brief summary is provided below.

In the reactor core, the uranium oxide fuel is cooled by water, which also acts as the neutron moderator necessary for a sustained nuclear fission reaction. The heat from the primary coolant is used to produce steam in a secondary circuit, via a steam generator. Steam from the secondary circuit drives a turbine-generator to produce electricity. The primary coolant remains within the primary circuit (Figure 3-1).

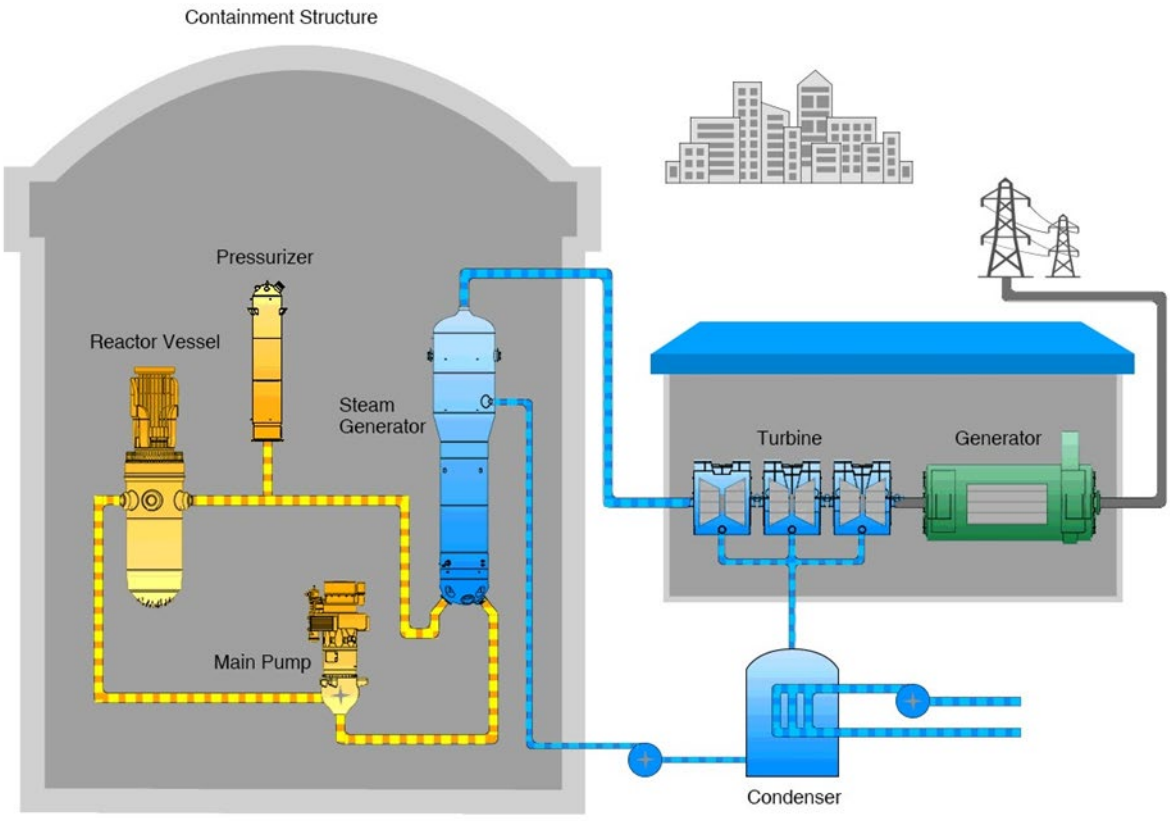

Figure 3-1 A simplified diagram of the internal workings of the UK HPR1000

Image copyright of China General Nuclear

The main ancillary facilities include a spent-fuel storage pond, spent-fuel interim storage facility, water treatment systems for maintaining the chemistry of the water circuit, diesel

generators for providing power in the event of loss of grid supplies, and waste treatment and storage facilities. Turbine condenser cooling water may be provided by a once-through system or by cooling towers.

There are no units of the CGN designed HPR1000 operating yet, but there are 5 units under construction in China (Fangchenggang units 3, 4 and Taipingling units 1 and 2 and Sanaocun unit 1). Fangchenggang unit 3 is the reference design for the UK HPR1000.

The HPR1000 design is an evolution of previous power station designs, including the M310 design (4 units in operation), the CPR1000 (18 units in operation) and the ACPR1000, with 8 units in operation (Yangjiang units 5 and 6 and Hongyanhe unit 5) and 1 unit currently under construction (Hongyanhe unit 6).

3.2. Sources, processing and disposal of radioactive waste

Radioactive waste will arise from activities associated either directly or indirectly with operating and maintaining the reactor, and ultimately, from decommissioning the plant. In particular, operating a PWR generates radioactive waste in the water of the primary coolant circuit.

Liquid radioactive discharges arise mainly from effluent associated with systems for collecting and treating the primary coolant water. Other sources of such effluent include the spent-fuel storage pond, washings from plant decontamination, drainage from change-rooms, let-down of secondary circuit coolant, and effluent from the active laundry (if present on site). Effluent treatment facilities include storage, hold up tanks, filters, demineraliser ion exchange resin beds and evaporators. Facilities to monitor effluents before they are released are provided.

The main source of gaseous radioactive emissions is from within the primary coolant circuit which, at outage, is degassed to the gaseous waste treatment system (GWTS) which is a charcoal bed delay system. This system slows down the radioactive gases, allowing much of the short-lived radionuclides (in particular, xenon and krypton) to decay before they are released into the atmosphere. Gaseous radioactivity will also be present in the main process buildings, which are serviced by the heating, ventilation and air-conditioning (HVAC) systems. Discharges from these systems are via a main stack, which is expected to be located on the top of the fuel building. There is provision for monitoring these discharges, after they have been filtered through high efficiency particulate air (HEPA) filters.

Other radioactive waste includes spent ion exchange resins, spent filter media, worn out plant components and parts replaced during plant maintenance, contaminated protective clothing and tools, rags and tissues, and waste oil. Facilities for managing these types of waste include resin storage tanks, space for providing waste treatment and packaging facilities, and storage areas for packaged low-level and intermediate-level waste. All radioactive plant components are likely to become waste when the plant is decommissioned. Similar waste currently produced in the UK is disposed of via the

national Low Level Waste Repository (LLWR) in Cumbria or stored, pending disposal, at a future deep geological disposal facility (GDF).

Spent fuel will be stored under water in the spent-fuel storage pond for a period of time. It is then transferred to an interim spent fuel store until transported to a GDF for disposal. The site includes space for a spent fuel interim storage facility.

3.3. Non-radioactive waste

Non-radioactive waste is produced from operating and maintaining the plant. It includes:

- combustion gases discharged to the air from the diesel generators (emergency back-up power supply)
- secondary circuit discharges, containing water-treatment chemicals from the turbine-condenser cooling system and other non-active cooling systems, which is discharged to rivers or the sea
- oils
- redundant plant and components replaced during plant maintenance
- general waste, such as waste from offices and canteens

Non-radioactive substances will also be present in the radioactive waste and may affect its impact on the environment and how it is managed and disposed of. For example, liquid radioactive discharges will contain boron compounds. Boron (a neutron absorber) is added to the primary coolant circuit to help control reactivity in the core.

Waste, surface water and other discharges, and the need for dewatering abstraction, would also arise during construction, as for any major construction project, and also in operation and decommissioning. These are out of the scope of GDA, as they are best considered if, or when, site-specific proposals are made.

4. Guide to our detailed assessment

This chapter explains where you can find details of our assessment of specific topics in the rest of this document, and gives some general information about the conclusions of our detailed assessment.

4.1. Detailed assessment topics

In the following Chapters 5 to 17, we set out our conclusions for:

- management systems (Chapter 5)
- radioactive substances regulation topics
    - strategic considerations for radioactive waste management (Chapter 6)
    - best available techniques for minimising the creation and disposal of radioactive waste (Chapter 7)
    - discharges of gaseous and aqueous radioactive waste (Chapter 8)
    - solid radioactive waste (Chapter 9)
    - monitoring discharges and disposals of radioactive waste (Chapter 10)
    - impact of radioactive discharges (Chapter 11)
- other environmental regulation topics
    - water abstraction (Chapter 13)
    - non-radioactive discharges to surface waters and groundwater (Chapter 14)
    - operation of installations (Chapter 15)
    - control of major accident hazards (Chapter 16)
    - fluorinated gases and ozone depleting substances (Chapter 17)

The detailed assessments summarised in Chapters 5 to 17 are based on those provided in the consultation document but updated, where necessary, to reflect:

- our assessment of any further information the RP has provided since the consultation date
- the further work that we said, in the consultation document, that we intended to do
- matters arising from ONR's GDA Step 4 work that are relevant to our assessment
- any changes arising from our consideration of relevant consultation responses
- any changes arising from our consideration of relevant comments received on the RP's website, and the RP's responses

Our conclusion on the acceptability of the design for radioactive substances permitting is set out in Chapter 12 and that on the overall acceptability of the design in Chapter 18.

A full description of our detailed assessment can be found in our separate assessment reports published to the GDA: General Nuclear System Limited's UK HPR1000 nuclear power design document collection:

- AR01 - Management systems for the UK HPR1000 design

- AR02 - Strategic considerations for radioactive waste management for the UK HPR1000 design
- AR03 - Best available techniques for the UK HPR1000
- AR04 - Gaseous and liquid discharges of radioactive waste for the UK HPR1000 design
- AR05 – Solid radioactive waste, spent fuel and disposability for the UK HPR1000 design
- AR06 - Monitoring of discharges and disposals of radioactive waste for the UK HPR1000
- AR07 - Generic site and impact of radioactive discharges for the UK HPR1000
- AR08 - Other environmental regulations for the UK HPR1000

4.2. About our conclusions

Our conclusions identify a number of Assessment Findings, which will need to be cleared at an appropriate point during the plant procurement, design development, construction, commissioning programme or early operation. These Assessment Findings relate to:

- matters that are normally addressed during the construction or commissioning phase (for example, demonstration that as-built plant realises the intended design)
- matters that depend on site-specific characteristics or operator preferences

These matters cannot be addressed during GDA, so are carried forward to be considered at the appropriate time.

5. Management systems

We assessed the RP's management and quality assurance arrangements against the requirements and expectations as set out in Table 1, Item 2 of our Process and Information Document (P&ID) (Environment Agency, 2016). We carried out our assessment in 2 stages, in line with the process set out in the P&ID.

Stage 1 entailed initial assessment of GNSL's arrangements, and the GDA arrangements in place in its service provider organisations (CGN and EDF). This stage comprised a review of documents and records, and inspections at GNSL's offices in England, CGN's offices in China, and EDF's offices in France. The findings from stage 1 were set out in our Environment Agency initial assessment report (Environment Agency, 2018a).

Stage 2 entailed detailed assessment of the management and quality arrangements, plus follow-up on areas identified during the initial assessment where further work was required to fully meet the expectations set out in our P&ID. We carried out our detailed assessment work through correspondence, meetings, and further visits, inspections and workshops in England, China and France. We raised Regulatory Queries (RQs) and Regulatory Observations (ROs), sometimes jointly with the Office for Nuclear Regulation (ONR), in relation to questions or observations arising from these engagements.

The outcome from our assessment is reported in our final detailed assessment report: AR01 – Management systems for the UK HPR1000 design (Environment Agency, 2022a). In summary, our assessment findings are as follows.

5.1. Developing the design

GNSL and its service providers have employed adequate numbers of suitably qualified, trained and experienced people to support the development of the UK HPR1000 design and the associated GDA submissions. This includes using specialist contract organisations to provide support to ensure that the design and safety case meet regulatory expectations in England. We are satisfied that the capacity and capability of the organisation for developing the design are adequate.

5.2. Managing the generic design assessment (GDA) project

GNSL has a formal management system in place which meets the specifications set out in relevant guidance and standards, including IAEA GSR Part 2, relevant Environment Agency and ONR guidance, and the ISO9001 and 14001 standards (albeit, for GNSL, without formal accreditation to the ISO standards given their limited organisational lifespan). There is an appropriate organisational structure in place, including governance and internal assurance arrangements. Management procedures and associated documentation are fully developed and implemented. We are satisfied that management system and quality assurance arrangements are adequate for the UK HPR1000 GDA project.

5.3. Establishing the method for identifying the best available techniques (BAT) and making sure they are used in the design

The RP has addressed BAT explicitly in developing the design. Formal procedures for carrying out BAT assessment are in place, implemented by suitably qualified and experienced people, both suitably trained people within the RP, and specialists from the supply chain. Similarly, arrangements for operating experience (OPEX) have been developed and implemented to support the identification of BAT. BAT decisions have been used in developing the design, and are recorded. We are satisfied that an appropriate BAT methodology has been developed and implemented in the development of the UK HPR1000 design.

At the time of consultation, we had identified shortfalls in identification and use of OPEX as a potential GDA Issue, which was captured under RO-UKHPR1000-044. This RO and potential GDA Issue is now closed (see Appendix 12).

5.4. Producing and maintaining the submission

GNSL has formal arrangements in place for development and quality assurance of the safety case, such that the final Pre-Construction Environmental Report submissions present a suitable and sufficient demonstration that the UK HPR1000 design could meet environmental permitting requirements in England, subject to submission of suitable site-specific permit applications. We have assessed these arrangements and found them to be adequate.

5.5. Ongoing communications with the regulators and responding to matters they raised during GDA

GNSL has formal procedures in place for engaging with regulators and for responding to matters raised during GDA. Throughout the project there have been frequent meetings and engagements (including workshops and inspections) to facilitate our assessment of the UK HPR1000 generic design. The RP has adequately responded to all formal Regulatory Queries and Regulatory Observations raised as part of our assessment.

5.6. Maintaining records of design and construction

The RP has formal procedures in place for maintaining documents and records. We have assessed these procedures, and inspected samples of these records, and found them to be adequate.

5.7. Controlling and documenting design modifications, both during and after completion of GDA

GNSL has formal arrangements in place for design development, configuration management and design change control. These arrangements are integrated with equivalent arrangements employed by CGN as the designer. We assessed the effectiveness of these arrangements and, although most were satisfactory, we found some

shortcomings in relation to the specified requirements for design change review, and the rigour of their application. Regulatory Observation RO-UKHPR1000-0024 was raised on this matter. The RP has fully responded to the RO, and we have subsequently confirmed by inspection that appropriate changes to the procedures have been made, and that the changes are effective in addressing the previous shortcomings.

5.8. Transferring information to potential operators and providing ongoing support to them throughout the reactor's life cycle

The RP has developed and implemented processes for transferring information about the UK HPR1000 technology to a future operator. An important element of this is to ensure that the GDA documentation presents a clear and coherent description of the design. It must set out BAT claims, arguments and evidence clearly, including underpinning requirements and assumptions. On the basis of our assessment of the RP's documents and procedures, we are satisfied that this is the case. Some aspects of the design are intended to be completed by a future operator. We have identified one Assessment Finding in relation to this, as follows:

Assessment Finding 1: The future site operator shall develop arrangements for managing GDA commitments, Assessment Findings, requirements and assumptions relating to environmental protection aspects of the design.

Overall, our conclusion is that the RP’s management and quality arrangements meet the requirements and expectations set out in our P&ID document, and are sufficient to support the development of the generic design for the UK HPR1000 reactor.

6. Strategic considerations of radioactive waste management

This chapter covers our assessment of the RP's strategic considerations of radioactive waste management when developing the design. This includes its general approach to producing and managing radioactive waste and, in particular, its approach to the longer term issues of decommissioning and dealing with spent fuel.

The outcome from our assessment is reported in our final detailed assessment report: AR02 – Strategic considerations for radioactive waste management for the UK HPR1000 design (Environment Agency, 2022b). In summary, our assessment and our Assessment Findings are as follows.

6.1. General approach to radioactive waste management

Our Radioactive Substances Regulation Environmental Principles (REPs) (Environment Agency, 2010a) set out the matters that we expect an integrated waste strategy (IWS) should take into account. In addition, we expect an IWS to also include information as noted in our P&ID (Environment Agency, 2016), government policy statements (DECC, 2014), and to make reference to the specification and guidance provided by the Nuclear Decommissioning Authority (NDA) (NDA, 2012).

Our assessment is based mainly on the IWS document the RP submitted (GNSL, 2021a). The IWS document is a supporting document to Chapter 4 of the Pre-Construction Environmental Report (PCER) (GNSL, 2021b). It is important to note that there are significant overlaps with some of our other assessment reports, most notably 'AR05 - Solid waste, spent fuel and disposability' (Environment Agency, 2022e) and 'AR03 - Best available techniques' (Environment Agency, 2022c).

The scope of the IWS covers the following aspects (GNSL, 2021a):

- the facilities that generate, store, treat and process the wastes and waste packages
- design features that have been incorporated to prevent or minimise waste arising
- design features that have been incorporated to monitor and minimise the radioactive and non-radioactive discharges
- UK HPR1000 waste management principles and how they align with UK national policies and regulatory context
- outline of UK HPR1000 waste management organisation and arrangements to ensure that the wastes can be managed safely and in an environmentally responsible way
- engagements with external stakeholders in developing this integrated strategy
- how the approach to waste management is developed and optimised in an integrated way
- strategy for managing all radioactive, non-radioactive waste and spent fuel, from construction through operation to decommissioning

- links to other underpinning documents and references
- areas requiring further development

We consider the scope of the IWS described above to be in line with current guidance and therefore to meet our expectations.

The RP describes a number of principles it has followed in developing the IWS. These include:

- applying the waste management hierarchy to all wastes
- using BAT to minimise the impact of discharges and disposals
- the importance of good characterisation
- sorting and segregation at source to ensure effective subsequent disposal
- minimising waste
- optimising decay storage to reduce the activity of radioactive wastes
- using the 'concentrate and contain' principle where ‘concentrate and contain’ involves trapping the radioactivity in a solid, concentrated form for storage and eventual disposal rather than the ‘dilute and disperse’ option that involves the direct discharge of gaseous or liquid radioactivity into the environment (DECC, 2009a)

We consider the waste management principles presented by the RP to be appropriate for a nuclear power station’s integrated waste strategy.

We, and ONR, have issued a number of RQs (and ONR has issued one Regulatory Observation) concerning strategic radioactive waste management throughout the GDA process. Following assessment of the RQ responses, amendments have been incorporated into the RP’s IWS document.

We note that the RP cannot provide detailed operational aspects necessary to develop a fully integrated waste strategy at this time. The IWS is as comprehensive as it can be with the information currently available and is appropriate for the GDA stage. A future operator is expected to develop its own strategy from the RP’s IWS by adding operational or site-specific detail when it is available and taking account of relevant developments.

Two crucial aspects of strategic waste management that cannot be concluded during GDA relate to the proximity principle and economies of scale. We therefore consider the following Assessment Finding appropriate to ensure these important issues are addressed as the site-specific plans develop:

Assessment Finding 2: If a future site operator has multiple sites, an assessment of best available techniques (BAT) should be produced which covers all of its sites, noting the proximity principle, economies of scale and other efficiencies in disposal of solid and incinerable liquid wastes. The assessment should form part of a future operator’s submissions for its second and subsequent environmental permit applications.

6.2. Higher activity waste and spent fuel

The government has indicated that new nuclear power stations should proceed on the basis that spent fuel will not be reprocessed, and that both spent fuel and intermediate level radioactive waste (ILW) will be disposed of to a geological disposal facility (GDF) when it is available (DECC, 2011d). Since these disposals are unlikely to occur until late this century, this means that the strategy needs to consider on-site storage and management of both ILW and spent fuel for the lifetime of the power station, or an appropriate alternative.

We expect a spent fuel strategy to be in line with government policy (DECC, 2011d and 2014) and our REPS (Environment Agency, 2010a).

The strategy the RP presented in the IWS document is in line with the above requirements and consists of the following 3 stages:

- short-term storage in the spent fuel ponds
- interim dry storage on-site
- off-site disposal in a geological disposal facility

Our assessment of spent fuel (which is considered to be waste) is covered below in section 9 - solid radioactive waste and in our assessment report AR05 - Solid waste, spent fuel and disposability (Environment Agency, 2022e).

6.3. Decommissioning

In line with government policy, we expect decommissioning of the plant to be considered at the design stage, with a view to ensuring that it can readily be carried out, while minimising the volumes of decommissioning wastes and minimising the impacts on people and the environment of decommissioning operations and the management of those wastes.

For decommissioning, in line with government policy (DECC, 2009b, 2011 and 2014) and our REPs (Environment Agency, 2010a), we expect:

- the radioactive waste and spent fuel strategy to address decommissioning
- the design to use the best available techniques (BAT) to:
    - facilitate decommissioning
    - minimise arisings of decommissioning waste
    - minimise the impacts on people and the environment of decommissioning operations and managing decommissioning waste

The IWS includes consideration of decommissioning and introduces the decommissioning strategy. The details of the decommissioning strategy are developed in a number of supporting documents, which include a Preliminary Decommissioning Plan (GNSL, 2021c) and a Decommissioning Waste Management proposal (GNSL, 2021d).

The Preliminary Decommissioning Plan (GNSL, 2021c) presents the optioneering work the RP carried out to determine that an immediate, rather than deferred, decommissioning strategy is the preferred option.

The Decommissioning Waste Management proposal document (GNSL, 2021d) provides more detail on specific waste streams. In this document, the RP acknowledges that the majority of the decommissioning wastes will be different from the operational waste streams generated throughout most of the plant's life cycle. However, it should be noted that some waste streams will remain the same between the operational and decommissioning phase.

Non-radioactive solid wastes, being out of scope of GDA, are only covered in the main IWS document and are not developed any further in the supporting documents, which focus on radioactive decommissioning wastes.

Our assessment of decommissioning wastes is also covered below in section 9 - solid radioactive waste and in our assessment report AR05 - Solid waste, spent fuel and disposability (Environment Agency, 2022e).

6.4. Our overall conclusions on strategic considerations for radioactive waste management

Our conclusions are that:

- the RP has provided an acceptable waste strategy for all waste streams within the scope of the GDA. The details underpinning the integrated waste strategy (IWS) in this respect are considered in greater detail in our relevant assessment reports for individual waste streams and disposability (Environment Agency, 2022c, 2022d, 2022e)
- the RP's IWS, together with its other submissions, will help to ensure people and the environment are properly protected. The details underpinning the IWS in this respect are considered in greater detail in our assessment report on the assessment of doses to the public and to wildlife (Environment Agency, 2022g)
- the IWS is consistent with government policy statements (DECC, 2014) and current regulatory expectations

We have identified no potential GDA Issues and one Assessment Finding, as set out above.

More details of our assessment of strategic considerations for radioactive waste management can be found in our detailed assessment report AR02 – Strategic considerations for radioactive waste management for the UK HPR1000 design (Environment Agency, 2022b).

7. Best available techniques for minimising creation and disposal of radioactive waste

We assessed the RP's submission on best available techniques (BAT) against the requirements and expectations as set out in Table 1, Items 2, 4 and 5 of our Process and Information Document (P&ID) (Environment Agency, 2016).

Our assessment has considered the RP's submission in relation to relevant UK policy, legislation and guidance, including the Environment Agency's Radioactive Substances Regulation (RSR) Environmental Principles (REPs) (Environment Agency, 2010a). The most relevant principles include:

- Radioactive Substance Management Developed Principle 3 (RSMDP3): Use of BAT to minimise waste
- RSMDP4: Processes for identifying BAT
- RSMDP7: BAT to minimise environmental risk and impact
- Engineering Developed Principle 2 (ENDP2): Avoidance and minimisation of impacts
- ENDP4: Environment protection functions and measures

We carried out our assessment in 2 stages: initial assessment, followed by detailed assessment. The findings from our initial assessment are set out in our Environment Agency initial assessment report (Environment Agency, 2018a). The detailed assessment built on that initial assessment and is based on additional submissions and ongoing technical engagement with the RP. The outcome from our assessment is reported in our final detailed assessment report: AR03 - Best available techniques for the UK HPR1000 design (Environment Agency, 2022c). In summary, our assessment findings are as follows.

7.1. Process for identifying BAT

The RP's process for identifying BAT has suitably recognised the relevant principles of optimisation and sought to apply these in presenting the GDA BAT case. The approach has been guided by considering standard environmental permit conditions and P&ID requirements relating to optimisation (Environment Agency, 2016). The RP's approach has been to set out claims, develop arguments in support of these, and to provide the relevant supporting evidence, where possible. The approach of using claims, arguments and evidence (CAE) is commonly used for nuclear new build projects, including previous GDAs to demonstrate the application of BAT. The CAE approach recognises that the UK HPR1000 is an evolution of earlier pressurised water reactor (PWR) technology and reflects on design improvements that are relevant to the BAT claims. We consider this to be a sensible approach and a suitable method by which to consider the 'BAT case' for generic design assessment of the UK HPR1000.

The RP's approach has also included identifying aspects relating to BAT that a future operator will need to action at the detailed design and permitting stage. These aspects have been identified as forward action plans (FAPs). We consider this to be a useful approach and recognise the value of these FAPs.

At consultation, we had identified a potential GDA Issue, noting that the BAT case could not be considered complete until the systems relevant to BAT were also considered to be ALARP by ONR, as a design needs to be optimised to fulfil both requirements. This potential GDA Issue is now closed (see Appendix 12).

7.2. Optioneering

The RP's approach to optioneering for the UK HPR1000 is aimed at generating and evaluating options to address potential enhancements to the design in accordance with the legal requirements relating to BAT, which we regulate. the RP's optioneering method and process have varied in terms of the specific approaches to scoring and sensitivity analysis. We recognise that different approaches are possible and consider that the approach the RP adopted has been appropriately scoped and is consistent with our expectations for GDA. Overall, our conclusions are that the RP has used optioneering approaches where appropriate, targeting those aspects that are relevant to the UK design and, where prompted, in response to specific regulatory considerations, for example, to justify specific design option selection.

7.3. Generation, minimisation and management of radioactive waste

Most radionuclides in the reactor core are retained either as fission products within the fuel pins or as activation products within core structures. However, a small amount of radioactivity can transfer from the fuel or structure into the primary coolant through leaks, diffusion, tramp uranium (small amounts of residual uranium from the manufacturing process on the outside of the fuel) or corrosion product activation. The coolant circuit clean up system will remove some radionuclides into waste treatment resins. A very small proportion of those radionuclides in the primary coolant can transfer to the secondary coolant system (in the case of steam generator (SG) tube leaks and diffusion) and be removed by the waste management systems. We have illustrated the main sources and flow paths for radioactive wastes within the UK HPR1000 in Figure 7-1, a simplified diagram adapted from figures in Demonstration of BAT (GNSL, 2021e).

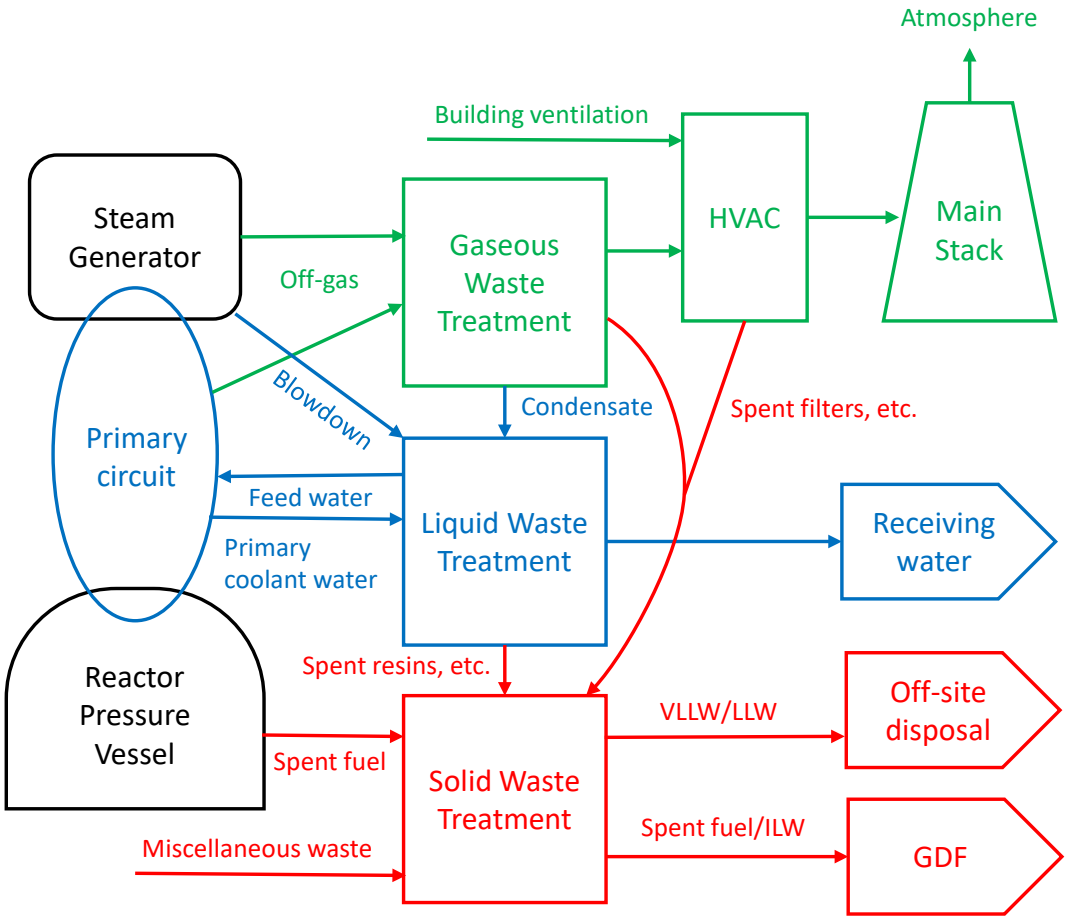

Figure 7-1: The gaseous, liquid and solid wastes routes

The demonstration of BAT for minimising and managing radioactive waste in the UK HPR1000 is presented in the GDA submissions. The RP has identified the radionuclides that will contribute significantly to the amount of activity in waste disposals and will result in doses to members of the public. The RP has presented, for the normal operation source term, the mechanisms that generate radionuclides in the reactor core and the primary circuit and the methodology for selecting appropriate radionuclides. Normal operation includes, start-up and shutdown procedures, standard operations, maintenance and testing activities and includes frequent events that can be expected to occur during the life-time of the operation of the plant. The RP also quantified the radionuclides distribution in the radioactive systems under normal operation conditions. Our conclusions are that a demonstration of BAT has been provided for the UK HPR1000 to minimise and manage radioactive waste.

The RP has described how radioactive substances will be processed in the UK HPR1000 to ensure that waste is appropriately managed for disposal, considering the application of the waste hierarchy and BAT principles. We note that the RP cannot provide detailed operational aspects of relevance to the BAT case, although broad operational aspects are discussed. This is appropriate for the GDA stage, as a future operator would decide how the plant is operated. We will expect further details on how the plant will be operated to ensure that BAT is implemented in the site permitting phase.

Limits and conditions of operation relevant to the BAT case are the limits on plant operating parameters necessary for environment protection. The RP has included consideration of environmental protection in operating rules, technical specifications and environmental safety management requirements.

7.4. Processing radioactive substances

Once radioactivity is circulating in the reactor primary coolant, its subsequent processing and handling will determine its ultimate distribution between gaseous, aqueous and solid waste streams. We expect the techniques used to be consistent with the principle of the preferred use of 'concentrate and contain' in the management of radioactive waste over 'dilute and disperse' (DECC, 2009a). This means that, provided it is BAT to do so, radioactive waste should preferentially be produced as, or converted to, a solid waste. We also expect BAT to be used to ensure that the distribution of any residual radioactivity between gaseous and aqueous waste streams minimises the overall impact of discharges to the environment.

7.4.1. Processing gaseous waste

Through our assessment of relevant claims, argument and evidence (CAE) for processing gaseous waste we observe the following:

- Using a modern and well-established fuel design and further measures to reduce fuel failure rates will help to minimise gaseous waste arisings by limiting releases from fuel failure.
- Using delay bed technology is effective at reducing discharges of noble gases and consistent with approaches adopted in other pressurised water reactors (PWRs). Delay beds are also expected to have some effects on reducing the concentration of short-lived iodine radionuclides.
- Using HEPA filters is effective at abating discharges of radioactive particulates.
- The UK HPR1000 design aims to discharge the remaining gases and particulates that cannot be concentrated and contained at height, via a main stack. This will minimise the impacts of those discharges by adequate dispersion in the environment.
- We believe the design minimises radioactive discharges to the environment, subject to assessment of operational choices to be considered at the site-specific stage.
- We agree with the RP that no abatement of tritium or carbon-14 is practicable currently (GNSL, 2021f)) and this is in line with all other PWRs (International Atomic Energy Agency (IAEA), 2004).
- We agree with the RP that a future operator should review the need for secondary neutron sources (SNS) to reduce the production of tritium, provided it can make a safety case to do this.

7.4.2. Processing liquid waste

Through our assessment of relevant CAE for processing liquid waste we observe the following:

- Using a modern and well-established fuel design, and further measures to reduce fuel failure rates should help to minimise liquid waste by limiting fission product releases from failed fuel.
- The UK HPR1000 design enables clean-up and reuse of liquids within the plant, therefore avoiding unnecessary discharges. The UK HPR1000 uses filters, demineraliser and evaporator technology to remove radioactivity from liquids which are standard equipment in nuclear power stations.
- We agree the design minimises radioactive discharges to the environment, subject to assessment of operational choices to be considered at the site-specific stage.
- No abatement of liquid tritium is practicable as although some tritium abatement technologies exist, none have been successfully used on a PWR to separate the low concentrations of tritium present in aqueous wastes. We agree it would be unreasonable to use techniques at this time to avoid liquid disposals of tritium, given the small dose impact.

7.4.3. Processing solid waste

Solid radioactive wastes are produced during the operational and decommissioning phases of a power station's life cycle. The UK HPR1000 design has a waste management strategy and system based on available treatment technologies and current and assumed future disposal facilities (see section 6). The nature of the solid wastes that will arise in the UK HPR1000 is described further in section 9.

The solid waste treatment system is designed to collect, segregate, treat, condition, package and store various types of operational solid radioactive wastes which are categorised as high level waste (HLW), intermediate level waste (ILW), low level waste (LLW) and very low level waste (VLLW) before being transported off-site. The RP describes facilities capable of treating, interim and decay storing, where appropriate, and managing the disposal of solid radioactive wastes in accordance with the chosen options for managing these wastes, as described in the RP's 'Radioactive Waste Management Arrangements' submission (GNSL, 2021b).

7.5. Claims, arguments and evidence

Our systematic assessment of the RP's CAE in relation to best available techniques is detailed in our final detailed assessment report: AR03 – Best available techniques for the UK HPR1000 design (Environment Agency, 2022c). The Demonstration of BAT submission (GNSL, 2021e) is divided into 5 claims and each claim contains a number of arguments which are supported by numerous pieces of evidence detailed in the subsidiary GDA submissions:

- prevent and minimise the creation of radioactive waste and spent fuel
- minimise the radioactivity of gaseous and aqueous radioactive wastes discharged into the environment
- minimise the impact of discharges on people and non-human biota
- minimise the mass/volume of solid and non-aqueous liquid radioactive wastes and spent fuel

- select the optimal disposal routes for wastes

We examined the claims made by the RP about minimising waste and the impact on the environment. We also considered the evidence supporting these claims in relation to good practice in the UK. We submitted 2 ROs and over 20 RQs relating to our assessment of BAT. The RP's responses to our regulatory enquiries provided further information to support the claims and resulted in the creation and update of a number of GDA submissions. Our conclusion from assessing the claims is that the UK HPR1000 has demonstrated that BAT can be used to prevent and minimise the creation of radioactive waste, support the principle of 'concentrate and contain' and minimise the overall impact of discharges to the environment.

7.6. Regulatory Observation resolution

Going into our public consultation we identified a potential GDA Issue that required the RP to demonstrate how BAT is applied for the choice of high efficiency particulate air (HEPA) filter design. Based on the submissions made, we judged there were potential shortfalls in demonstrating that the optioneering study and justifying the choice of HEPA filter comprehensively considered minimising fugitive discharges, energy use and the production and disposal of radioactive waste. The RP's response to RO-UKHPR1000-0036 was to revise its HEPA filter type optioneering report as it committed to in its resolution plan. This was sufficient and resulted in the RO and potential GDA Issue being resolved (Appendix 12).

The RP's approach to requirements management includes the development of environmental requirements and identifying systems that provide an environmental protection function (EPF – ENDP4). The RP provided a list of structures, systems and components (SSCs – ENDP11) and engineered controls that contribute to the application of BAT. RO-UKHPR1000-0051 was about demonstrating the adequacy of examination, maintenance, inspection and testing (EMIT – ENDP11) of structures, systems and components (SSCs) that provide an EPF. Our expectation was that the RP's environment case should include a demonstration that the EPF of SSCs can be maintained at all times under normal operations. The resolution to RO-UKHPR1000-0051 included creating and updating a number of GDA submissions to improve the demonstration of BAT.

7.7. Conclusion

Our conclusion is that the RP has adequately demonstrated BAT in relation to radioactive substances for the UK HPR1000, based on the defined scope for GDA (GNSL, 2019a) and in line with our expectations for GDA. Our assessment of BAT for monitoring is provided in the monitoring assessment report, AR06 (Environment Agency, 2022f). Operational aspects of BAT will be assessed if we receive a site-specific permit application.

We have identified a number of Assessment Findings that we will expect a future operator to address. These are:

- **Assessment Finding 3: A future operator shall develop arrangements for managing environment protection measures. This should include specification, procurement, manufacturing, commissioning and operation, including examination, maintenance, inspection and testing requirements.**
- **Assessment Finding 4: A future operator shall consider the potential high efficiency particulate air (HEPA) filter sealing performance technique improvements being considered for nuclear new builds, including Hinkley Point C to ensure application of good practice.**
- **Assessment Finding 5: A future operator shall have arrangement to periodically review the practicability of techniques for abating carbon-14.**
- **Assessment Finding 6: A future operator shall periodically review the possibility to remove secondary neutron sources or to optimise their design at the earliest opportunity.**
- **Assessment Finding 7: A future operator shall demonstrate that the UK HPR1000 will be operated in a way that represents best available techniques for the selection and change strategy of demineraliser resins and filters for liquid waste management systems.**
- **Assessment Finding 8: A future operator shall address the BAT relevant post-GDA commitments the Requesting Party identified in the Post-GDA Commitment List, GHX00100084KPGB03GN.**
- **Assessment Finding 9: A future operator shall assess the impact of its proposed operating fuel cycle on the radioactive waste generation and disposal before implementing any changes.**
- **Assessment Finding 10: A future operator shall specify procedures to detect failed fuel and act to minimise discharges to the environment.**
- **Assessment Finding 11: A future operator shall periodically review and continue to optimise water chemistry regimes presented during GDA to reduce waste generation.**
- **Assessment Finding 12: A future operator shall demonstrate that the dissolved nitrogen level in the primary coolant is minimised.**
- **Assessment Finding 13: A future operator shall define a procedure to follow in the event of leakage to the secondary circuit that demonstrates the discharge of activity to the environment is minimised.**
- **Assessment Finding 14: A future operator shall periodically review and continue to optimise the balance between gaseous, liquid and solid phase disposals of carbon-14.**
- **Assessment Finding 15: A future operator shall assess the chemical form of carbon-14 discharged to the environment and use this to help inform future dose assessments.**

8. Discharges of gaseous and liquid radioactive waste

This chapter covers our assessment of the RP's estimates of gaseous and liquid discharges and the proposed limits that the UK HPR1000 would comply with.

The outcome from our assessment is reported in our final detailed assessment report: AR04 – Gaseous and liquid discharges of radioactive waste for the UK HPR1000 design (Environment Agency, 2022d). In summary, the outline of our assessment and our assessment findings is as follows.

8.1. Sources of gaseous and liquid radioactive waste

We expect new nuclear power stations to use BAT to minimise the radioactivity in discharges of gaseous and liquid radioactive waste, and to minimise the impact of those discharges on the environment. Applying BAT is covered in section 7 above and our assessment report on best available techniques (Environment Agency, 2022c).

Information on the sources of gaseous and liquid radioactive wastes, quantification of arisings and discharges, and the RP's proposed limits is provided in: 'Pre-Construction Environmental Report, Chapter 6, Quantification of Discharges and Limits v2' (GNSL, 2021g).

In this section, 'liquid radioactive wastes' refers to aqueous liquid radioactive wastes only, which excludes non-aqueous liquid wastes such as oils. Although liquid and gaseous wastes are subject to filtration, discharges may include small amounts of particulate material.

8.1.1. Gaseous radioactive wastes

There are 3 main systems that handle gaseous radioactive waste:

- gaseous waste treatment system (GWTS)
- heating ventilation and air-conditioning (HVAC) system
- condenser vacuum system (CVS)

All 3 systems combine in the HVAC system for discharge to air through a single site main stack. The RP has summarised the gaseous effluent discharge routes in the following diagram:

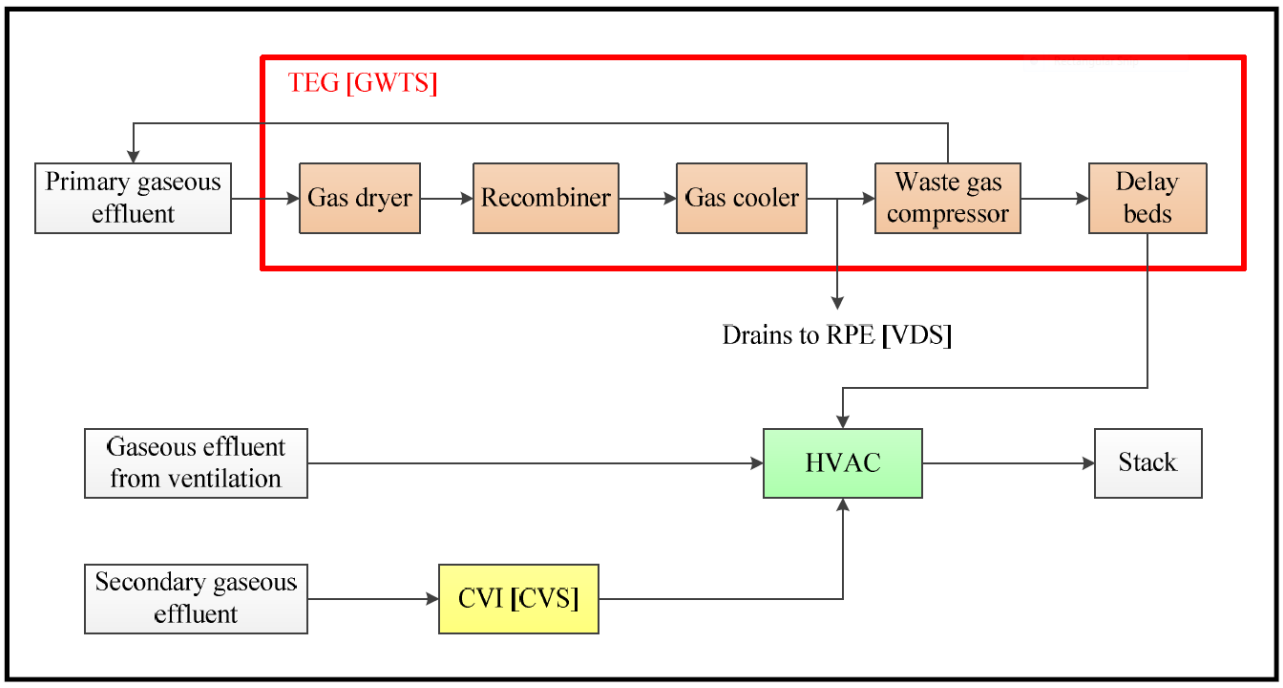

Figure 8-1: Radioactive gaseous effluent streams (GNSL, 2021g, section 6.4)

System abbreviations used in Figure 8-1 are as follows:

- CVI[CVS], condensate vacuum system
- HVAC, heating ventilation and air conditioning
- RPE[VDS], nuclear island vent and drain system
- TEG[GWTS], gaseous waste treatment system

The diagram shows how the 3 systems link together to treat and manage the 3 categories of gaseous effluents; primary effluent, gaseous effluent from ventilation and secondary effluent (Figure 8-1).

The main site stack is the single emission point for gaseous radioactive waste. The waste stream is monitored continuously to collect data to demonstrate compliance with the discharge limits which will be included in a radioactive substances environmental permit for a future site. We assess sampling and monitoring in section 10 below and our assessment report on monitoring (Environment Agency, 2022f).

The treatment techniques used in the gaseous waste management system are the delay beds in GWTS and high efficiency particulate air (HEPA) filters in the HVAC system. There is also the option to use iodine adsorbers in the HVAC system if necessary.

8.1.2. Liquid radioactive wastes

Liquid radioactive wastes go through a number of collection and treatment systems before being discharged into the environment. All of the liquid effluents described here flow to the ‘seal pit’ before being discharged through a single site outfall. The seal pit is a structure designed to prevent air getting back into the cooling water and effluent systems and is linked to the main site outfall into the environment.

The system can be summarised in the following diagram (Figure 8-2):

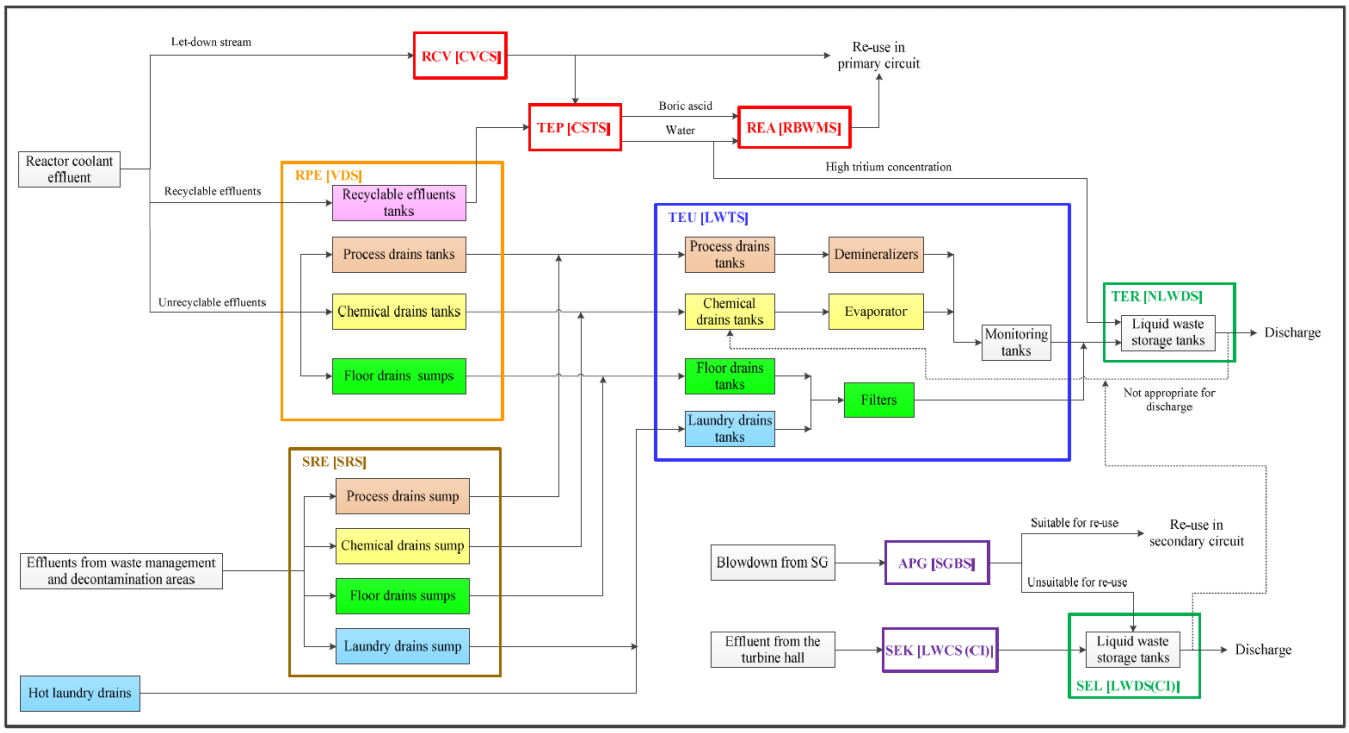

Figure 8-2: Radioactive liquid effluent streams (GNSL, 20201g, section 6.4)

System abbreviations used in Figure 8-2 are as follows:

- APG[SGBS], steam generator blowdown system
- RCV[CVCS], chemical and volume control system
- REA{RBWMS], reactor boron and water makeup system
- RPE[VDS], nuclear island vent and drain system
- SEK[LWCS(CI)], waste fluid collection system for conventional island
- SEL[LWDS(CI)], conventional island liquid waste discharge system
- SRE[SRS], sewage recovery system
- TEP[CSTS], coolant storage and treatment system
- TER[NLWDS], nuclear island liquid waste discharge system
- TEU[LWTS], liquid waste treatment system

The liquid waste streams can be divided into 3 categories; reactor coolant effluent, effluents from waste management and decontamination areas and secondary circuit effluent (steam generator blow-down and turbine hall effluent).

The treatment options used in the liquid waste treatment system (LWTS) are filtration, demineralisation and evaporation. These liquid treatment techniques are consistent with those used internationally in similar nuclear power stations.

8.2. Our assessment of the method for quantifying discharges and limits

The main elements of the RP's method for quantifying discharges and limits are as follows:

- defining operating conditions
- selecting relevant OPEX
- identifying significant radionuclides
- deriving correction factors
- deriving headroom factors
- deriving appropriate expected events

Each of the above elements generated radionuclide specific information that was used to calculate discharge estimates and limits.

We identified a number of shortfalls in our first full assessment of the information the RP submitted and issued a Regulatory Observation (RO-UKHPR1000-0010). The approach the RP used did not initially follow the regulatory expectations set out in our P&ID (Environment Agency, 2016), so in the RO we asked the RP to revise how it had approached using OPEX, its calculation method and the presentation of data. Detail of the RO can be found in our detailed assessment report 'Gaseous and liquid discharges of radioactive waste for the UK HPR1000 design', AR04 (Environment Agency, 2022d). After the RP had carried out further work, we were satisfied with its response and closed the RO in June 2020.

We issued a number of Regulatory Queries throughout the GDA process. Following assessment, the responses the RP provided were incorporated into revisions of the documents that make up the RP’s submission, which now meet our expectations for GDA.

Based on the outcome of the RO and RQs, the calculation methodology elements can be summarised as follows:

Operating conditions - the RP defines the operating conditions used for quantifying discharges and limits to be routine operation, start-up and shutdown, maintenance and testing, and expected events. These operational conditions were further refined into one of two operational states, either 'power operation' or 'shutdown'. The RP clearly defines which operating conditions apply in each operational condition.

Selecting relevant OPEX - the RP's approach was to source its data from OPEX rather than theoretically deriving it from a source term calculation.

Significant radionuclides – the RP has used our guidance on limit setting (Environment Agency, 2012) to derive a set of significant radionuclides.

Correction factors were derived to account for any differences between OPEX data and the UK HPR1000 design proposals.

Headroom factors are important to take account of the uncertainty in the OPEX data used to derive the discharge limits. They enable a future operator to comply with the proposed limits without unduly affecting its ability to operate the plant. We require headroom factors to be minimised as much as possible. We acknowledge that there may be considerable uncertainty in data presented at GDA stage, so we consider the following Assessment Finding appropriate to ensure the headroom is the minimum necessary to permit normal operation of the power station.

Assessment Finding 16: A future operator shall keep the headroom factors derived during GDA under review. Operational data generated by the UK HPR1000 should be used to periodically revise the headroom factors to ensure they are the minimum necessary to permit normal operation.

Expected events - the RP provided a list of 'expected events' relevant to operating a UK HPR1000. Expected events are classed as a 'normal operation' and are therefore in scope of GDA and form part of our approach to setting permit limits on discharges to the environment. Other events inconsistent with using BAT (such as accidents or inadequate maintenance) are not considered 'normal operation' and therefore don't form part of our assessment at GDA.

We consider the methods used and conclusions the RP reached in relation to establishing operating conditions, selecting relevant OPEX, significant radionuclides, correction factors, headroom factors and contribution of expected events to meet our expectations for GDA. More detail of our assessment of each element can be found in our detailed assessment report 'Gaseous and liquid discharges of radioactive waste for the UK HPR1000 design' AR04 (Environment Agency, 2022d). Once the various factors described above had been established, the RP used them in a series of calculations to determine discharge estimates and proposed limits.

The specific outputs of the calculations were:

- estimated monthly discharges
- estimated annual discharges

These discharge estimates were then used to calculate:

- proposed annual discharge limits

Calculations are also presented to derive maximum monthly discharge estimates (GNSL, 2021x). These estimates provide an indication of possible variations in short-term discharges during normal operation which would remain within specific annual limits. These discharge variations may lead to short-term increases in discharges and can be caused by expected events, variation in plant parameters and standard operating practices. The maximum monthly discharges presented are used solely as an input to the radiological impact assessment of short duration releases, which is included in PCER Chapter 7 - Radiological Assessment. Our view on this assessment is presented in section 11, which covers the radiological impact assessment.

We have assessed the RP's calculations used to derive discharge estimates and limits and are satisfied that our limit setting guidance (Environment Agency, 2012) has been followed and that the P&ID requirements have been met (Environment Agency, 2016). The estimated discharges and proposed limits are as follows (Table 8-1 and Table 8-2):

Table 8-1. Estimated discharges and proposed limits for gaseous discharges (Bq).

Radionuclide	Monthly discharges during power operation (Bq)	Monthly discharges during shutdown (Bq)	Annual discharge (Bq)	Proposed annual limit (Bq)
H-3	4.71E+10	1.82E+11	8.34E+11	5.23E+12
C-14	1.75E+10	9.91E+10	3.74E+11	1.69E+12
Noble gases	6.69E+10	2.71E+11	1.21E+12	1.56E+13
Xe-133	5.00E+10	2.02E+11	9.04E+11	1.16E+13
Xe-135	1.48E+10	5.99E+10	2.68E+11	3.45E+12
Halogens	4.79E+05	6.33E+06	1.75E+07	2.21E+08
Other radionuclides	3.15E+05	3.58E+05	3.86E+06	1.12E+07

Table 8-2. Estimated discharges and proposed limits for liquid discharges (Bq).

Radionuclide	Monthly discharges during power operation (Bq)	Monthly discharges during shutdown (Bq)	Annual discharge (Bq)	Proposed annual limit (Bq)
H-3	1.63E+12	5.27E+12	2.69E+13	1.04E+14
C-14	7.67E+08	3.71E+09	1.51E+10	5.90E+10
Other radionuclides	1.84E+07	7.49E+07	3.33E+08	1.04E+09

8.3. Comparison of UK HPR1000 discharges with other similar reactors around the world

The RP has provided a comparison of the discharge estimates and proposed limits derived above with other similar reactors worldwide. The RP approached this by carrying out a comparison with previous PWR GDAs and then with other publicly available international OPEX from the UK, France, Germany and USA. Information related to the comparison can be found in the Pre-Construction Environmental Report Chapter 6 – Quantification of discharges and limits (GNSL, 2021g).

The RP reviewed the publicly available information on the previous GDAs for the UK EPR and the UK AP1000. Acknowledging the difference in methods for quantifying discharges and limits used by each RP, the RP carried out an indicative comparison of the data normalised to 1,000 megawatt electrical power (MWe). This is an acceptable approach as it enables as meaningful a comparison as possible to be carried out. For example, discharges of gaseous tritium (H-3) and carbon-14 (C-14) are both proportional to power output, so normalising the data to 1,000 MWe enables these radionuclides to be better compared. The results show that for all radionuclides, except gaseous H-3 and C-14 and liquid tritium (H-3), the UK HPR1000's discharges are the same or slightly lower than the other PWRs. The RP has confirmed that the differences relate to the Environment Agency guidance available at the time of each GDA, the different approaches to calculating headroom, the contribution of expected events and the calculation of proposed limits. We consider the explanations provided to be satisfactory.

In order to make a meaningful comparison with international OPEX, the RP took the annual averages from the international OPEX and the annual discharge estimates from the UK HPR1000 and then normalised them to 1,000 MWe. The UK HPR1000 annual discharges are broadly similar to the international OPEX from similar plants around the world. Where differences are evident, the RP has provided a number of considerations and conclusions to explain the variance (GNSL, 2021g). We have described our assessment in more detail in our detailed assessment report 'Gaseous and liquid discharges of radioactive waste for the UK HPR1000 design' - AR04 (Environment Agency, 2022d).

We consider that the information the RP provided in this section demonstrates that the UK HPR1000 discharges and limits are generally comparable with international OPEX and previous GDAs. Where there are differences, we are satisfied with the RP’s explanations.

8.4. Our overall conclusions on gaseous and liquid radioactive waste

Our conclusions are that:

- the RP has provided us with information on estimated gaseous and liquid discharges and proposed limits

- the proposed annual gaseous and liquid discharge limits for the UK HPR1000 are clearly derived, taking into account our limit setting guidance (Environment Agency, 2012)
- we consider that the RP has demonstrated that the UK HPR1000 discharges and limits are generally comparable with international OPEX and previous GDAs. Where there are differences, we are satisfied that the RP has provided reasonable explanations
- the gaseous and liquid discharges from the UK HPR1000 would be capable of complying with the limits set out above (Tables 8-1 and 8-2)

We have identified no potential GDA Issues and one Assessment Finding, as set out above.

More details of our assessment of gaseous and liquid discharges of radioactive waste can be found in our detailed assessment report ‘AR04 - Gaseous and liquid discharges of radioactive waste for the UK HPR1000 design’ (Environment Agency, 2022d).

9. Solid radioactive waste

This chapter covers our detailed assessment of the RP's submission on solid radioactive waste, spent fuel and disposability of waste for the UK HPR1000 as required in Table 1 of our P&ID (Environment Agency, 2016).

Our assessment has considered the submission in relation to relevant UK policy, legislation and guidance, including our REPs (Environment Agency 2010). We have also considered our 'Joint guidance on the management of higher activity radioactive waste on nuclear licensed sites' (Office for Nuclear Regulation and others, 2021).

We assessed the RP's derived waste inventory for the UK HPR1000 covering operational and decommissioning wastes as well as spent fuel. We assessed the RP's proposed approach to managing these wastes across the whole facility life cycle, from commissioning through to operations and decommissioning. This included covering characterisation, segregation, conditioning and packaging, storage and final disposal. We also assessed proposals for managing both lower activity wastes (LAW) and higher activity wastes (HAW).

The packaging of spent fuel into a disposal container and its subsequent transfer to a geological disposal facility (GDF) is out of scope of GDA. The management of failed fuel within the spent fuel interim store (SFIS) is also out of GDA scope. Failed fuel is in scope for GDA, whilst in the spent fuel pool.

We identified 3 potential GDA Issues as part of our preliminary assessment for our consultation concerning:

- the management of in-core instrument assemblies (ICIAs) (related to RO-UKHPR1000-037)
- the requirements for the long-term storage of spent fuel and the SFIS design
- the disposability of HAW and spent fuel (RO-UKHPR1000-041)

These Issues and the associated ROs have now been resolved as a result of the additional information the RP provided (see Appendix 12).

Following our assessment, we concluded that:

- all solid and non-aqueous wastes have been identified
- a good description of the quantities, activities and composition for the majority of the solid wastes and spent fuel arisings has been provided. A good description of how solid wastes and spent fuel arisings will e minimised at source is provided to the level of information that we would expect for GDA
- all low level waste (LLW) arisings from the UK HPR1000 are likely to be disposable, but there are a number of site-specific issues for a future operator to address
- the design of the UK HPR1000 has considered the minimisation of waste during decommissioning. We note that the decommissioning plan will continue to be developed as part of the detailed design stage

- we are confident that the design can facilitate effective characterisation and segregation to the solid wastes for the UK HPR1000. However, a future operator will need to develop arrangements and demonstrate that best available techniques (BAT) are being applied
- we are confident that the options chosen for conditioning and packaging of the HAW solid wastes can produce disposable products. Radioactive Waste Management Ltd (RWM) has raised a number of issues that will need to be addressed as part of the future disposability process that a site operator will undertake
- we are content that the RP has demonstrated that the conceptual design for the intermediate level waste (ILW) store represents BAT and that the packages will be maintained in an environment that will ensure that they will be disposable. We will expect a future operator to continue to assess the application of BAT for the construction and operation of the second stage of the stores

We have raised 16 Assessment Findings, numbers 17 to 32, these are listed in Appendix 2 and in the text below.

A summary of our detailed assessment is given below, together with links to further supporting documents. Further detail can be found in the final assessment report for this topic, AR05 – Solid radioactive waste, spent fuel and disposability for the UK HPR1000 design (Environment Agency 2022e).

9.1. Operational waste arisings

The RP provided an outline of the solid and non-aqueous wastes which will arise during the operational phase of the life cycle for the UK HPR1000, within the 'Pre-Construction Environmental Report (PCER) - Radioactive Waste Management Arrangements' (GNSL, 2021b). The major classes of radioactive wastes that will arise during the operational phase of the reactor's life cycle will be very low level waste (VLLW), low level waste (LLW), intermediate level waste (ILW) and high level waste (HLW). We summarise the waste arisings from the UK HPR1000 within Appendix 8.

We raised a number of RQs with regard to the LLW and ILW inventory that will arise as a result of operating the UK HPR1000. Our detailed assessment report (AR05) provides further information with regard to these queries (Environment Agency, 2022e).

In general, we found the information met our expectations for GDA, subject to the following assessment finding being addressed by a future site operator:

Assessment Finding 17: A future operator shall ensure that its characterisation programme will identify any hazardous materials and non-hazardous pollutants, to ensure that the inventory for disposal is accurate, for the UK HPR1000.

9.2. Decommissioning wastes

To determine the preferred option for decommissioning the UK HPR1000, the RP has carried out an optioneering exercise (GNSL, 2021c). The RP identified immediate decommissioning as the preferred option for the UK HPR1000. This aligns with the UK government's policy for the decommissioning of nuclear new build (BEIS, 2020). The RP has proposed a Decommissioning Waste Management Plan, which provides an initial decommissioning inventory for the UK HPR1000 (GNSL, 2021d) and summarises how these wastes could be managed. We summarise the decommissioning wastes within Appendix 9.

Best practice for decommissioning is that the generation of waste is either prevented or minimised (Environment Agency, 2010a). The RP needed to demonstrate that decommissioning considerations have been integrated into the design of the reactor, that the waste management hierarchy has been applied, and that radioactive waste management solutions have been optimised.

We are content that the method used to derive the decommissioning inventory for the UK HPR1000 is applicable for GDA. We provide more information with regard to this within our detailed assessment report (Environment Agency, 2022e). We also note that the major HAW streams are similar to those identified for other reactors in other GDA assessments. However, we note that the decommissioning inventory will be further refined during the operational phase of the UK HPR1000, as more information becomes available.

9.3. Spent fuel and non-fuel core components (NFCCs)

Spent fuel is regarded as a waste within GDA, as currently there is no intention to reprocess the spent fuel from new nuclear reactors. This is consistent with the UK government's policy for new nuclear reactors (BEIS, 2020). The RP has decided to use Framatome's AFA 3GAA fuel assembly. This is a uranium dioxide pellet fuel, based on modern engineering standards. The number of spent fuel assemblies (SFAs) that will be produced over a 60-year operational lifetime for the UK HPR1000 will be 2,985.

The RP highlighted a number of NFCC wastes that will be produced over the operational period. These will be HLW and ILW wastes. The NFCCs consist of rod cluster control assemblies (RCCAs), stationary core component assemblies (SCCAs) and in-core instrument assemblies (ICIAs).

We are content that the inventory with regards to spent fuel and NFCCs appears reasonable for GDA. The inventory for the SCCAs may be further refined in the future depending on the decision that a future operator makes regarding the removal of secondary neutron sources.

9.4. Minimising solid radioactive waste and spent fuel arisings

Our P&ID document (Environment Agency, 2016) and our REPs (Environment Agency, 2010a) require the RP to demonstrate that BAT has been applied and that the generation

of wastes has either been prevented or minimised. Our review of the supporting evidence the RP provided is discussed in detail within our BAT assessment report (Environment Agency, 2022c). However, within our AR05 detailed assessment report we provide a summary of how the RP has applied BAT to minimise the production of solid wastes and spent fuel (Environment Agency, 2022e).

We assessed the information the RP provided with regard to the following:

- fuel design, manufacture and operation
- controlling the chemistry of the primary coolant
- material selection of components in contact with the primary circuit
- building layout
- maintenance of equipment and life cycle of components

The information provided meets with our expectations for GDA.

We also assessed how the RP had applied BAT to minimising the wastes that will arise in decommissioning the UK HPR1000. In particular, our assessment focused on whether the design of the UK HPR1000 had taken account of decommissioning. We also assessed how the RP proposed that a future operator would decommission the UK HPR1000 using techniques that are currently available.

We raised a number of RQs with regard to the decommissioning of the UK HPR1000, but were generally content with the information provided for GDA. However, we have identified 2 Assessment Findings:

Assessment Finding 18: A future operator shall assess whether there are benefits in periodic decontamination of the UK HPR1000 primary circuit and its related systems and auxiliary circuits, during the operational phase, with regard to minimising production of decommissioning wastes and their classification. The future operator should demonstrate that BAT is being applied.

Assessment Finding 19: A future operator shall ensure that the decommissioning plan is periodically reviewed to demonstrate that BAT is being applied with regard to decommissioning the UK HPR1000.

9.5. Managing solid waste and non-aqueous wastes

Our requirements for waste management practice are to ensure that waste:

- is sorted and segregated
- maintained within the principle of ‘concentrate and contain’
- can be appropriately characterised and packaged
- upstream practices do not affect disposability

The national policies in China and the UK are different and there are differences in the approaches to managing solid and non-aqueous radioactive wastes. A Regulatory Observation was raised (RO-UKHPR1000-005, plus associated RQs), part of which aimed

to identify what gaps exist between the different approaches, within the UK and China, for managing the radioactive wastes that will arise from the UK HPR1000. The gaps that the RP identified were:

- treatment of ion exchange resins
- dry active waste segregation and treatment process
- oils and organic solvents treatment process
- low activity spent resins and ventilation filter cartridges management process
- management of RCCAs, SCCAs and ICIAs
- ILW waste shielding container
- ILW/LLW waste storage areas

To address the above gaps, the RP carried out an optioneering exercise to identify the preferred options for managing solid and non-aqueous waste (GNSL, 2020a). We have assessed this report and more information is provided within our detailed assessment report (Environment Agency, 2022e). We are content with the RP's approach. The preferred options are summarised within Appendix 8 under 'waste management route'.

9.6. Managing and disposing of lower activity wastes (LAW)

For this GDA, the UK's LLW Repository in Cumbria is the preferred option for the treatment and final disposal of all LAW that arises from the UK HPR1000 reactor. Our P&ID document requires the RP to demonstrate that LAW arisings from the UK HPR1000 can be treated and disposed of via the routes available within the UK (Environment Agency, 2016).

The RP has provided us with information about the buildings and systems that will be involved in the management of the LAW. It has also provided us with an overview of how samples will be taken, characterisation and also conditioning of the wastes. We are content with the information provided for GDA and discuss this in more detail within our detailed assessment report, AR05 (Environment Agency, 2022e).

We require an RP to demonstrate that all LAW arisings from the UK HPR1000 will be disposable. The RP has sought an agreement in principle from LLWR Ltd with regard to its plans to condition and dispose of LAW arisings from the UK HPR1000. LLWR Ltd has raised a number of points where further information will be required from a future operator (LLWR Ltd, 2020). We provide more information on these points within our detailed assessment report (Environment Agency, 2022e). In response to LLWR Ltd's agreement in principle, the RP has addressed each of the points raised to demonstrate that a future operator should be able to address them (GNSL, 2020b). We have assessed both the advice from LLWR Ltd and the RP's responses to that advice. We have no reason to believe that a future operator could not address the points LLWR Ltd raised, if the LLW repository was the chosen destination for the wastes. Consequently, we see no reason why the LAW wastes arising from the UK HPR1000 will not be disposable.

For decommissioning LLW and VLLW, the RP has estimated the volumes of wastes that will arise from decommissioning the UK HPR1000 reactor. However, for GDA, the RP is

not required to seek disposal advice from LLWR Ltd for the treatment and disposal of decommissioning LLW, as it is currently out of scope of GDA.

We are content that for GDA, the RP has provided sufficient information and has met our requirements. However, we have identified an Assessment Finding to ensure that a future operator will engage with the operator for the disposal facility:

Assessment Finding 20: A future operator shall review periodically the options for the treatment and disposal of solid low level waste from the operation and decommissioning of the UK HPR1000. The future operator shall ensure that the options implemented are BAT and will meet the disposal facilities waste acceptance criteria.

9.7. Managing higher activity waste (HAW)

The higher activity waste (HAW) arisings from the operation and decommissioning of the UK HPR1000 reactor will be ILW, HLW and spent fuel. Currently, the UK has no disposal route for HAW. RWM is in the process of engaging with communities across England and Wales with regard to the siting of a geological disposal facility (GDF). Therefore, at present all HAW is stored within engineered stores on nuclear licensed sites, pending disposal to a GDF.

9.7.1. Joint guidance on managing higher activity wastes

The regulators' (Environment Agency, the Office for Nuclear Regulation, Natural Resources Wales and the Scottish Environment Protection Agency) expectations with regard to the management of HAW are stipulated within the document 'Joint guidance on the management of HAW' (Office for Nuclear Regulation and others, 2021). This guidance provides an overview of the regulators' expectations with regard to the characterisation, segregation, conditioning, packaging, storage and disposal of HAW. It also highlights the expectations with regard to records and knowledge management. A main requirement of the joint guidance is for a future licensee to produce a Radioactive Waste Management Case (RWMC).

The RP has produced 2 RWMCs; one details the arrangements for managing the ILW arising from the UK HPR1000 (GNSL, 2021h), while the second highlights the arrangements for HLW (GNSL, 2021i). The RWMCs which the RP has produced meet with our expectations for GDA, with regards to ensuring that the management of HAW should protect people and the environment. The RWMCs should provide a future operator with a good foundation on which to further build the HAW arrangements for the UK HPR1000. A future operator should continue to update the RMWCs, as and when required, in accordance with this joint guidance. We have identified an Assessment Finding to ensure that a future operator will do this:

Assessment Finding 21: A future operator shall periodically update the Radioactive Waste Management Case or equivalent documentation in accordance with the Environment Agency's and ONR's joint guidance, in order to demonstrate that the higher activity waste is being managed across the whole life cycle.

9.7.2. Managing operational and decommissioning HAW

For the UK HPR1000, the RP plans to process the operational HAW solids through the solid waste treatment system. We discuss this further within our detailed assessment report (Environment Agency 2022e). Decommissioning wastes with similar characteristics to the operational solid wastes are likely to be processed through the solid waste treatment system. However, in some cases, the system may have to be modified, so that the decommissioning wastes can be processed. Additional facilities may also be required to characterise, segregate and condition the decommissioning wastes.

9.7.3. Characterisation and segregation

To meet our expectations, it is essential that the RP can demonstrate that characterisation and segregation of the wastes is possible for the UK HPR1000. The RP has provided an overview of the processes and locations for sampling solid radioactive wastes for the UK HPR1000 (GNSL, 2021j).

Grab sampling is one of the main techniques used for sampling HAW solids, such as ion exchange resins, condensates and sludges. The RP will also use dose measurements and scaling factors as methods to characterise the solid wastes, such as spent filters and ILW dry active wastes. The information provided gives us confidence that the sampling of the solid wastes is likely to be feasible for the UK HPR1000.

Segregation of the UK HPR1000 HAW wastes should be achieved by separating the different classification of wastes when they are generated or by processing the different wastes via different routes, which have been incorporated into the design of the UK HPR1000. The RP has provided a number of examples to demonstrate that wastes can be segregated, and further detail of these examples is provided within our detailed assessment report.

With regard to decommissioning wastes, the RP acknowledges the importance of characterisation and segregation in minimising the volumes of radioactive waste produced during decommissioning and in maximising the amount of solid waste that can be recycled or reused. Within the RP's decommissioning plan, we note that it is intended that a future operator will carry out a full characterisation survey of the UK HPR1000 reactor and licensed site before decommissioning. The RP has made best use of the OPEX available internationally to identify the technologies that could be used today to decommission the UK HPR1000. This OPEX provides further evidence to demonstrate that a future operator can use effective segregation during decommissioning to optimise the use of the UK's disposal capacity.

We are content that the RP has demonstrated the importance of characterisation and segregation both during operations and decommissioning. However, a future operator will need to further develop the characterisation and segregation strategies and processes to ensure that the techniques and approaches that will be applied will be BAT. We have identified Assessment Finding 22 to ensure that an operator does this:

Assessment Finding 22: A future operator shall develop its characterisation strategy and approach to segregation for solid and non-aqueous wastes further at the detailed design stage, to ensure that it can demonstrate that BAT is being applied.

9.7.4. Packaging and conditioning

The RP has carried out an optioneering exercise to assess a range of potential technologies to treat the HAW that will arise from the UK HPR1000 reactor (GNSL, 2020a). The RP also carried out an optioneering exercise to identify the preferred option for the containers in which the wastes will be packaged (GNSL, 2020c). We have assessed both these reports and are content that the information provided is sufficient for GDA. Further information with regard to the options chosen for each of the waste streams is provided within our detailed assessment report. A number of Regulatory Queries were raised with regard to the conditioning and packaging of the ILW wastes, which the RP has addressed as detailed in our assessment report (Environment Agency 2022e).

The RP has identified the preferred options for the conditioning and packaging of the ILW decommissioning wastes that will arise from the UK HPR1000 (GNSL, 2021d). Our detailed assessment report provides further information with regard to the options chosen (Environment Agency 2022e). We raised a number of Regulatory Queries with regard to the conditioning and packaging of the decommissioning wastes, which the RP has addressed as detailed in our assessment report (Environment Agency 2022e).

We are content that the options the RP chose are likely to lead to disposable packages. However, we note that, in a few cases, a future operator will need to demonstrate that the options the RP proposed will be BAT, especially for the decommissioning wastes. We have identified an Assessment Finding to ensure that a future operator will demonstrate that the options chosen for packaging and conditioning the HAW will still be BAT:

Assessment Finding 23: A future operator shall ensure that the proposed conditioning and packaging options for the higher activity wastes for the operational and decommissioning waste arisings from the UK HPR1000 are BAT.

9.7.5. Interim storage of operational and decommissioning HAW

In England, the Office for Nuclear Regulation (ONR) is the lead regulator for the accumulation and storage of wastes on a nuclear licensed site. However, our Regulatory Environmental Principles (REPs), RSMDP 10 and 11 indicate that operators should be able to demonstrate that the conditions of the actual store and the packages within it will be maintained (Environment Agency, 2010a). Our REPs also indicate that the packages should be able to be inspected and monitored during the storage period to ensure that they remain disposable in the future.

As the UK does not currently have a GDF, waste packages will be stored on site within environmentally controlled engineered stores. The design lifetime of the stores allows for packages to be stored on site for at least 100 years. The RP has considered international and UK guidance to develop its conceptual design for storing ILW for the UK HPR1000.

We note that the RP has made use of the guidance to industry on the interim storage of higher activity wastes (NDA, 2017). The RP has also used the Joint Guidance (Office for Nuclear Regulation and others, 2021) to understand the expectations with regard to the storage of HAW. A future operator will be expected to provide further information at the detailed design stage.

The RP has carried out a series of optioneering studies to assess the construction of the store, the stacking arrangement within the store and the type of storage area for the packages, such as shielded shaft or a vault. The RP has proposed, as the preferred option, that an ILW interim store will be constructed in 2 phases, and that the packages will be stacked vertically within the vaults within the store (GNSL, 2021k).

The RP argues that the 2-phased approach in constructing the stores will ensure that a future operator can make best use of the learning from the design and operation of the first store. This approach appears reasonable in ensuring that BAT will be applied at all times across the lifetime of the stores.

The RP has provided us with information with regard to the wastes that will be stored within the ILW stores. We are content that the stores' capacity should be sufficient to store all waste packages arising from the operation of the UK HPR1000.

The RP has provided further information with regard to the examination, monitoring and inspection of packages. The RP has provided an overview of the parameters that will need to be considered in ensuring that the condition of the packages will be maintained. We note that a future operator will need to develop its arrangements for identifying and managing any non-compliant packages with regard to the letter of compliance (LoC) envelope for the packages within the store to ensure that they will be disposable in the future and that no non-compliant waste packages are transferred to the GDF. We have identified an Assessment Finding to ensure this is completed:

Assessment Finding 24: A future operator shall develop arrangements for identifying and managing non-compliant waste packages, to ensure that only packages that are suitable for disposal would be transferred to a GDF.

We consider that the information provided is sufficient for the design of a conceptual level store for GDA. We will continue to review the design of the store as part of our ongoing regulatory process, along with ONR, during the detailed design stage and over the lifetime of the stores to ensure that BAT is being applied and that the packages will be disposable in the future.

9.8. Managing spent fuel and non-fuel core components

9.8.1. Spent fuel

We expect an RP to demonstrate that it has a credible strategy for managing spent fuel and that BAT will be applied to achieve this. the RP will need to demonstrate that fuel can be managed in an environmentally safe way and that disposal of the fuel to a future disposal facility will be possible. We provided the RP with a clarification of our

expectations for the scope of the demonstration the RP should provide for spent fuel (including SFIS) during GDA (Office for Nuclear Regulation and Environment Agency, 2018).

The RP's fuel management strategy requires the spent fuel assemblies (SFAs) to be stored within the spent fuel pool for a short period, typically between 5 and 10 years, followed by interim storage for a period of up to 100 years (based on the design lifetime of the store) (GNSL, 2021b, 2021l). After the interim storage period, a future operator will begin transferring the SFAs to a GDF.

The RP has carried out a detailed optioneering exercise to identify the preferred option for the interim storage of the SFAs (GNSL, 2019b). Two options were assessed in detail; one being wet storage of the spent fuel within a pool, while the second was dry storage within a metal canister/concrete silo arrangement. The RP identified dry storage within a metal canister/concrete silo as the preferred option.

In order for the spent fuel to be transferred from the spent fuel pool to the spent fuel interim store (SFIS), the fuel must be dried. We have assessed the information provided and this is adequate for GDA. However, we note that the drying process is dependent on the type of canister that will be chosen by the future site operator. We will expect a future operator to apply BAT when drying the SFAs and to specify the drying limits at the detailed design stage. We have identified the following Assessment Finding to ensure that a future operator does this:

Assessment Finding 25: A future operator shall ensure that it deploys BAT for the conditioning of the spent fuel, prior to transferring the spent fuel assemblies to the spent fuel interim store.

The SFIS design is at the conceptual level for GDA and would be further developed by a future operator at the site-specific stage. The RP proposes to construct the SFIS in 2 phases, with the first phase accommodating the spent fuel, HLW in-core instrument assembly (ICIA) arisings from the first 30 years of operation (GNSL, 2021m, 2021n). The RP argues that the 2-phase construction will allow a future operator to apply the learning from the first store to the design and operation of a second store.

We previously raised a GDA Issue within our preliminary assessment report requiring the RP to provide information with regards to the long-term storage requirements for the spent fuel as well as information that the conceptual SFIS design will have the capability to meet these requirements. The RP has provided this information which we have assessed, along with the ONR, who are the lead regulator for on-site interim storage of spent fuel. ONR is not content that the RP has provided sufficient evidence of the criteria that will preclude hydrogen embrittlement of the fuel cladding, by hydrogen realignment. However, ONR has undertaken an assessment of the versatility of the generic design of the UK HPR1000 to form a view on whether, at this stage, it forecloses any potential options for a future operator, with respect to satisfying the current, or any modified, criteria which need to be met for the safe interim storage of spent fuel. Based on the information available at this stage, ONR has concluded it is unlikely these fuel criteria could not be met d by the

current generic design of the UK HPR1000 (ONR, 2021). We are content that this is sufficient for GDA (see Appendix 12). However, we note that the current store design is at the conceptual level and a future site operator will need to ensure that, at the detailed design stage, these requirements will be met to ensure the integrity of the fuel.

We have therefore identified an Assessment Finding to ensure that during the site-specific stage a future operator addresses the following:

Assessment Finding 26: A future operator should ensure that the future design of the spent fuel interim store will deliver the long-term storage requirements for maintaining the integrity of the fuel, to ensure that it will be disposable in the future.

The monitoring and inspection of the canister and fuel is a crucial requirement in ensuring the integrity of the spent fuel assemblies during the interim storage period. We requested additional information with regard to this area. The RP has provided this, and additional information with regard to this area is provided within our detailed assessment report. However, we will expect a future site operator to ensure that the monitoring and inspection techniques applied within the interim store will be BAT and we have identified the following Assessment Finding:

Assessment Finding 27: A future operator shall ensure that the monitoring and inspection of the spent fuel assemblies and canister within the spent fuel interim store are BAT.

We sought further information from the RP with regard to the management of failed fuel, in particular with regard to its management within the spent fuel pool and in transferring the failed fuel to the SFIS. We wanted to ensure that the strategy in place for the UK HPR1000 would not rule out any disposal options for the failed fuel assemblies. We assessed the information provided and were content with this for GDA. However, we will expect a future operator to demonstrate that the current strategy for managing failed fuels for the UK HPR1000 will be BAT and we have identified the following Assessment Finding:

Assessment Finding 28: A future operator shall ensure that the strategy for managing failed fuel over the lifetime of the UK HPR1000 is BAT to minimise discharges and maintains fuel in an acceptable condition to enable its future disposal.

9.8.2. Non-fuel core components

The RP has provided us with information with regard to the life cycle management of non-fuel core components (NFCCs), which are rod cluster control assemblies (RCCAs), secondary core component assemblies (SCCAs) and ICIAs, which we have assessed (GNSL, 2021p).

For managing the RCCAs and SCCAs, the RP has chosen to store and dispose of these wastes together as an integral part of the SFA. The RP provided further information with regard to the characterisation and storage of the RCCAs and SCCAs within the spent fuel pool, and the potential for the RCCAs and SCCAs to degrade during storage within the

pool. It also provided information about whether there was sufficient capacity within the pool for the storage of these NFCCs and also whether their presence within the SFA would affect the drying process. We assessed this information and are content that the RP has provided sufficient information to give us confidence that the interim storage of RCCAs and SCCAs is unlikely to foreclose the disposal of these wastes.

The RP provided us with information with regard to the retrieval and packaging of the ICIAs. It also highlighted the options that were considered in managing these wastes. We note that previously within our preliminary assessment report, we had raised a GDA Issue regarding the management strategy for these wastes (see appendix 12). The information that the RP provided about the options study and additional information in how the wastes will be retrieved has addressed this Issue. We are content, from a disposal aspect, that the information provided is likely to lead to a disposable product and would not foreclose any future options.

9.9. Disposal of HAW and spent fuel

The current assumption and scope of GDA assumes that all HAW will be disposed of at a future GDF, in line with UK government policy. As a result, we expect the RP to obtain a view from RWM on the disposability of HAW and spent fuel (Environment Agency, 2016). We also expect the RP to consider and respond to the points RWM raised as part of its assessment. Our P&ID document requires the RP to identify a credible route for the disposal of the HAW arisings from the UK HPR1000.

The overall objective of the disposability assessment process is to provide confidence that the conditioning and packaging of the HAW and spent fuel from the UK HPR1000 will meet with RWM's current generic disposal system safety case (gDSSC) for an illustrative GDF. At this early stage in the development of the reactor design and operating regime, the proposals put forward by the RP are essentially just an outline. The detailed arguments and all the supporting evidence will not be available until the detailed design stage of the reactor and as it moves through its operational life cycle. The RWM disposability assessment process has 3 main stages, which a future operator will progress through to gain a letter of compliance (LoC) (NDA, 2014). For GDA purposes, a single stage disposability assessment process is provided for the Requesting Party (RP). Our detailed assessment report provides more information on the process and the wastes that RWM assessed as part of its assessment.

We have assessed RWM’s disposability assessment of the HAW and spent fuel arising from the UK HPR1000 and also the RP’s response on how a future operator may address the action points which RWM has raised as part of its assessment (GNSL, 2021q, GNSL 2021r and GNSL 2021s). We summarise RWM’s action points within Appendix 10 and 11 of this report. Our detailed assessment report provides further information on our assessment and our conclusions with regard to the disposability of the HAW waste arisings from the UK HPR1000 (Environment Agency 2022e). We are content that the RP has provided sufficient information to address the requirements within our P&ID (Environment Agency, 2016) and therefore to ensure that there is at least one disposal option for the HAW arisings from the UK HPR1000. However, we note that for the wastes

to be deemed disposable, a future site operator will need to address the actions points raised as part of the site-specific disposability assessment process, so we have identified the following Assessment Finding:

Assessment Finding 29: A future site operator should ensure that it addresses the disposability issues RWM raised within GDA as part of the site-specific disposability assessment process.

9.10. Managing records and knowledge management

Our REPs (Environment Agency, 2010a) and 'Joint guidance on higher activity wastes' (Office for Nuclear Regulation and others, 2021) provide our expectations with regard to managing records and knowledge.

The RP provided an overview of how it proposes to manage its records through its Management for Safety and Quality Assurance (MSQA) arrangements, which will be handed over to a future operator. However, it will be for a future operator to develop the specific systems and processes for managing waste package records. The RP provided a general overview of what information is likely to be retained as part of waste records, but this is not comprehensive. A future operator will need to engage with the operators of the disposal facilities to ensure that their requirements are captured for both LAW and HAW records. We have identified Assessment Finding 30 to ensure that a future operator does this.

The UK has limited experience regarding the dry storage of spent fuel and, in particular, its long-term storage. We note that the RP is aware of the significant international experience in relation to the dry storage of spent fuel. We will therefore expect a future operator to continue to make use of this knowledge and learn from it during the operational lifetime of the UK HPR1000. This will ensure that any issues that could impact on the disposal of spent fuel can be captured at the earliest opportunity. We have identified Assessment Finding 31 to ensure that this occurs.

The RP highlighted the importance of retaining records and knowledge that arises during the operation of the UK HPR1000 to optimise the decommissioning of the UK HPR1000 reactor. It has provided an overview as to what records and knowledge should be considered and why they are needed. The RP is aware of various decommissioning knowledge management repositories that exist internationally, which a future operator could also use.

The RP has provided sufficient information for GDA, however we have identified the following Assessment Findings:

Assessment Finding 30: A future operator shall engage with the operators of the disposal facilities to ensure that their requirements are complied with for both low activity wastes and higher activity wastes lifetime records.

Assessment Finding 31: A future operator shall continue to secure international OPEX with regard to the dry storage of spent fuels and ensure that it applies

learning from the international OPEX to the storage of the UK HPR1000 fuel arisings.

Assessment Finding 32: A future operator shall secure and use OPEX, including that available internationally, to ensure that BAT is used to decommission the UK HPR1000, and that the generation of radioactive solid waste is minimised and is capable of being disposed of.

10. Monitoring discharges and disposals of radioactive waste

We assessed the RP's sampling and monitoring arrangements against the requirements and expectations as set out in Table 1, Item 6 of our P&ID (Environment Agency, 2016). Our P&ID requires a description of the sampling arrangements, techniques and systems proposed for measuring and assessing discharges and disposals of radioactive waste.

Our assessment has considered the RP's submission in relation to relevant UK policy, legislation and guidance, including our REPs (Environment Agency, 2010a), the most relevant REPs being Radioactive Substance Management Developed Principle 13 (RSMDP13) – Monitoring and Assessment, and Engineering Developed Principle 10 (ENDP10) – Quantification of Discharges. Both principles require best available techniques (BAT) to be used for the activities being carried out.

We carried out our assessment in 2 stages: initial assessment, followed by detailed assessment. The findings from our initial assessment are set out in our Environment Agency initial report (Environment Agency, 2018a). The detailed assessment built on that initial assessment and is based on additional submissions and ongoing technical engagement with the RP. The outcome from our assessment is reported in our final detailed assessment report: AR06 – Sampling and monitoring for the UK HPR1000 design (Environment Agency, 2022f). In summary, our assessment findings are as follows.

The information the RP provided for gaseous (main stack on the fuel building) and liquid effluents, focusing on techniques, covers all the required areas associated with the requirements of GDA. There is also a demonstrated understanding of the issues, and commitments to fulfilling the requirements, that would be addressed in later phases of the new build process if proposals are brought forward.

For the UK HPR1000 gaseous effluent monitoring system, we have concluded that:

- BAT has been demonstrated in principle for monitoring systems at a level acceptable for GDA
- appropriate consideration has been given to the sampling line to ensure requirements for sampling can be met (through modelling penetration factors). Final confirmation of the acceptability of the sampling line will be needed once the position of the monitoring room has been finalised
- representative samples will be taken
- appropriate measurement and analysis will be carried out
- having the return of the sample to the discharge stack upstream of the sample extraction point will have a negligible effect on the discharge monitoring and is acceptable given the saving in pipework
- appropriate provision will be made to allow for independent regulatory verification of the gaseous monitoring and discharge reporting

For the UK HPR1000 liquid effluent monitoring system, we have concluded that:

- BAT has been demonstrated in principle for the monitoring systems
- representative samples will be taken of the final discharge
- appropriate flow measurement will be carried out
- appropriate analysis will be carried out
- appropriate provision will be made to allow for independent regulatory verification of the liquid monitoring and discharge reporting

The information the RP provided on sampling of solid and non-aqueous liquid radioactive wastes is an overview, since the monitoring systems for the waste generation, treatment and conditioning, and storage facilities have only been developed to concept level during GDA. Our conclusion is that the practices being developed appear appropriate for the monitoring of final disposal of these wastes. During site-specific permitting, more information will be required from a future operator on the specific sampling and monitoring equipment and sampling of solid and non-aqueous liquid radioactive wastes.

An environmental monitoring programme is not included within the scope of GDA due to the site-specific nature of such monitoring. This will need to be assessed at the site-specific stage.

We have identified 4 Assessment Findings that we will expect a future operator to address. These are:

Assessment Finding 33: A future operator shall demonstrate that, before signing the relevant procurement contracts, the selected sampling and monitoring equipment for determining the discharges are best available techniques, and enable the statutory required levels of detection to be met.

Assessment Finding 34: A future operator shall demonstrate, before reactor commissioning commences, that the final configuration of the sampling lines and the layout and positioning of the monitoring room are optimised to comply with ISO2889 and the use of best available techniques.

Assessment Finding 35: A future operator shall demonstrate that the systems and equipment used for monitoring and sentencing solid and non-aqueous liquid waste are best available techniques.

Assessment Finding 36: A future operator shall address the monitoring post-GDA commitments the Requesting Party identified in the Post-GDA Commitment List, GHX00100084KPGB03GN.

Overall, our conclusion is that the RP’s arrangements for sampling and monitoring meet the requirements and expectations set out in our P&ID document.

11. Impact of radioactive discharges

This chapter covers our assessment of the radiological impact of the proposed radioactive discharges from the UK HPR1000, that is, the radiation doses that people and other species might receive. We compared the calculated doses with national and international limits and standards to confirm that people and the environment will be adequately protected.

Dose calculations rely on models that predict how radioactivity from discharges moves through the environment and causes people and other species to be exposed to radiation, either externally or by breathing in air, drinking water or eating food. In GDA, we are not dealing with specific sites, so the dose calculations need to be done on the basis of a 'generic site' that has characteristics appropriate to sites in the UK, where nuclear power stations might be built. To be able to properly compare with standards and limits, the calculations include the predicted external radiation that comes directly from the nuclear power station, although this is a regulatory matter for ONR rather than the Environment Agency.

For the operation of a single unit of the UK HPR1000 with discharges at the annual limits specified in Chapter 8, our conclusion is that:

- the radiation dose to people will be below the UK constraint of 300 micro Sieverts per year (μSv/y), for any single new source
- the radiation dose-rates to local plant and animal life will be below our screening level of 10 micro Grays per hour (μGy/h) and so there will be no significant adverse impact on non-human species

We did not identify any potential GDA Issues or Assessment Findings.

11.1. Generic site description

Based on the latest generic site description in the RP's submission (GNSL, 2021t) and supporting documents, our conclusions are that:

- the RP has selected a coastal site to represent the generic site. As government's National Policy Statement for Nuclear Generation (DECC, 2011b and 2011c) notes that all potential sites for new nuclear power stations are either located on the coast or on large estuaries, we are content that selecting a coastal site is appropriate for GDA
- the generic site takes account of the characteristics of the Bradwell site. Many of the assumptions are those defined by the current Bradwell site. This means that the generic site is an estuarine location with relatively limited water exchange compared with other more open coastal locations. Therefore, the radiological assessment outcomes from liquid discharges are likely to be cautious and bounding

- for discharges to atmosphere, the atmospheric dispersion around the site is representative of all coastal locations and the radiological assessment outcomes are cautious overall
- the RP has assumed that there is no standing water on the site. We consider this to be reasonable and that surface water management will be a site-specific matter
- the RP has assumed that there are no discharges to freshwater. We consider this to be a reasonable assumption for a coastal nuclear site based on discharges from existing sites. Therefore, the radiological impact on protected freshwater species has not been assessed. This should be considered at site-specific environmental permitting, if appropriate
- we consider that the RP included appropriate factors in its generic site considerations as required by the Radioactive Substances Regulation Environmental Principles (REPs) SEDP1 – General principle for siting of new facilities and SEDP2 - Migration of radioactive material in the environment, and is broadly compliant
- we have not identified any Assessment Findings related to the generic site and there are no potential GDA Issues at the end of the GDA detailed assessment

11.2. Assessment of impact – doses to people

From the radiological assessment the RP submitted in PCER-07 (GNSL, 2021u), our conclusions are:

- all the doses the RP assessed for discharges from a single UK HPR1000 reactor at the proposed limits (see Chapter 8) are below the source dose constraint for members of the public of 300 μSv/y. Doses are also below the site dose constraint (500 μSv/y) and the public dose limit (1,000 μSv/y)
- our independent assessment from discharges at the proposed limits also showed doses to the public are below the site dose constraint
- the RP’s assessment is based on a generic site that takes account of the Bradwell site parameters. There is limited aquatic dispersion at the site and, therefore, doses are likely to be cautious and are expected to be bounding for the sites currently identified as possible locations for new nuclear power stations listed in the Nuclear National Policy Statement (DECC, 2011b and 2011c)
- it is very unlikely that doses at any site where the UK HPR1000 could be operated, including where several units were operated on a single site, would exceed the site dose constraint of 500 μSv/y and, therefore, it is very unlikely that the public dose limit of 1,000 μSv/y will be exceeded
- the RP’s assessment shows that the highest total dose from discharges and direct radiation is expected to be between 9.6 and 22.8 μSv/y from one reactor
- the RP's assessment included doses from short duration releases which ranges from 5.8 to 9.7 μSv/y
- most of the dose to the public is from discharges of carbon-14 to the atmosphere and carbon-14 in liquid discharges. Carbon-14 contributes more than 95% of the doses from discharges

- our independent assessment provides similar outcomes to the RP's assessment, which confirms low doses to the public (similar to the RP) and that the majority of the dose from discharges is from carbon-14
- we consider that the RP included an appropriate range of regulatory factors in its radiological assessment consideration as required by the Radioactive Substances Regulation Environmental Principles (REPs) (Environment Agency, 2010a) and is compliant. The RP has also taken into account good practice offered in the dose assessment principles (Environment Agency and others, 2012) and the relevant guidance from the National Dose Assessment Working Group
- we have no Assessment Findings related to the radiological assessment. However, as carbon-14 discharges contribute most to the dose, the outcome informs the Assessment Findings given in the BAT assessment report - requiring a future operator to review the practicability of techniques for abating carbon-14; for a future operator to assess the chemical form of carbon-14 discharged to the environment and use this to inform future dose assessments and to optimise the balance between gaseous, liquid and solid phase of carbon-14 (Environment Agency, 2022c)
- there are no potential GDA Issues related to the radiological assessment at the end of the GDA detailed assessment
- a detailed site-specific radiological assessment would be carried out if an environmental permit is applied for in future. The site-specific assessment would consider the actual environmental characteristics of the site and the number of reactors that will be present. This assessment will have to demonstrate that doses to members of the public from the UK HPR1000 will be as low as reasonably achievable (ALARA) and below relevant dose constraint and dose limits. Comparison against the dose limit would be carried out at site-specific permitting when contributions from all sources of radiation are known and can be included

11.3. Assessment of impact – wildlife

From the radiological assessment the RP submitted in PCER-007 (GNSL 2021u, 2021v), our conclusions are:

- that the atmospheric and liquid radioactive discharges from a UK HPR1000 at the generic site are unlikely to pose a radiological risk to wildlife
- the assessment the RP carried out is cautious and reasonable, and we consider that it has used an appropriate approach to assess the radiological impacts of the UK HPR1000 on wildlife
- for each reference organism, the probability of the dose rates exceeding the dose rate criterion of 10 µGy/h is less than 1%
- the highest dose rate to any reference organism from discharges to atmosphere is 0.15 µGy/h. The highest dose rate to any reference organism from liquid discharges is 0.0063 µGy/h. These dose rates are well below the dose rate criterion of 10 µGy/h
- that our independent radiological assessment for wildlife has broadly the same outcomes as the RP's. The highest dose rate to any reference organism from

discharges to atmosphere is 0.13 μGy/h. The highest dose rate to any reference organism from liquid discharges is 0.023 μGy/h. These dose rates are well below the dose rate criterion of 10 μGy/h

- this assessment relates to predictions of impact based on a generic site. A detailed impact assessment would be required at any future site-specific permitting, based on the actual environmental characteristics of the proposed site, to confirm that doses to wildlife will be below relevant dose rate criteria
- we have not identified any Assessment Findings and there are no potential GDA Issues related to radiological assessment at the end of the GDA detailed assessment

12. Our overall conclusion on radioactive substances permitting

We have assessed the UK HPR1000 design and set out our findings in Chapters 5 to 11. Our conclusions for these chapters are summarised below:

Management systems: The RP has developed specific management system arrangements for the GDA project. In developing its MSQA arrangements, the RP has considered relevant REPs (Environment Agency, 2010a). The arrangements include adequate capture and use of operating experience (OPEX), and adequate arrangements for handover of GDA information to a future licensee.

Best available techniques (BAT): The RP has recognised the relevant principles of optimisation and applied these in presenting the GDA case. Its approach has also been guided by considering standard environmental permit conditions and our GDA guidance. Overall, we conclude that the RP has followed an appropriate process for identifying BAT in the design of the UK HPR1000, to prevent and minimise the creation of radioactive waste, and to minimise the overall impact of discharges to the environment.

Gaseous and aqueous radioactive wastes: We conclude that the RP has provided us with sufficient information on estimated gaseous and liquid discharges and proposed limits. The proposed annual gaseous and liquid discharge limits for the UK HPR1000 are clearly derived, taking into account our limit setting guidance (Environment Agency, 2012) and are supported by suitable evidence. We conclude that the proposed discharge limits are of the appropriate size, and that discharges from the UK HPR1000 should not exceed those of comparable power stations across the world.

Solid radioactive wastes: We conclude that all solid and non-aqueous wastes have been identified. The RP has provided us with a good description of the quantities, activities and composition for the majority of the solid wastes and spent fuel arisings and how these have been minimised. Interim ILW storage on site has been demonstrated as being BAT. All LLW is expected to be disposable via LLWR. Higher activity solid wastes and spent fuel are likely to meet disposability criteria for the proposed national geological disposal facility, subject to future requirements identified by RWM.

Monitoring discharges and disposals: We conclude that the RP has demonstrated in principle the use of BAT for the UK HPR1000 for both the gaseous and liquid effluent monitoring systems. For the monitoring of solid and non-aqueous liquid radioactive waste, our conclusion is that the practices being developed appear appropriate for the monitoring of final disposal of these wastes, but a full assessment needs to be carried out when more information has been provided by a future operator.

Impact of radioactive discharges: Doses to the public from discharges and radiation from a single UK HPR1000 are in the range of 10 to 23 μSv/y. All doses are below the source dose constraint of 300 μSv/y. The radiological impacts are also below the dose criterion for wildlife of 10 μGy/h.

Overall, we conclude, subject to the Assessment Findings identified in Chapters 5 to 11, and summarised in Appendix 2, that the design should be acceptable for permitting for the disposal of radioactive waste at any coastal site consistent with the generic site as defined by the RP. The characteristics of this generic site envelop the sites included in the national nuclear policy statement, EN-6 (DECC, 2011b and 2011c), but detailed assessments specific for any proposed site would be required as part of application.

We do not believe that any of the Assessment Findings are so fundamental that they are unlikely to be resolved satisfactorily during site-specific permitting or post permitting work.

13. Water use and abstraction

This chapter covers our assessment of water use and abstraction.

Nuclear power stations need fresh water to use in the steam-raising circuits, other processes and 'domestic' purposes (for example, showers, toilets, laundry). They also need fresh or sea water for cooling the turbine condensers and other plant. Where water supplies are abstracted directly from groundwater (for example, via boreholes) or inland waters (for example, lakes, rivers or estuaries), a water abstraction licence is required.

The outcome from our assessment is reported in section 3 of our final detailed assessment report: AR08 – Other environmental regulations for the UK HPR1000 design (Environment Agency, 2022h). In summary, the outline of our assessment and our Assessment Findings is as follows.

13.1. Fresh water requirements

Information on other water use (fresh water) is provided in the RP's Pre-Construction Environmental Report (PCER) on Conventional Impact Assessment' (GNSL, 2021w).

The RP states that the GDA is based on the assumption that all fresh water requirements will be supplied by the local water company. This means that there will be no fresh water abstraction and, therefore, an abstraction licence is not required for the generic design. The RP considers fresh water supply to be a site-specific matter and leaves all options open for a future operator to consider. In order to ensure the need to explore all options is sufficiently highlighted, we consider the following Assessment Finding to be appropriate:

Assessment Finding 37: A future operator shall engage with the local water supply company early in the site-specific stage. This is to ensure that sufficient quantities of fresh water can be supplied to meet the requirements of the UK HPR1000 or to determine whether an alternative source of fresh water will need to be identified.

There are 3 parts of the design which use fresh water:

- demineralised water - estimated normal consumption 490m^3/day
- process water - estimated normal consumption 734m^3/day
- potable (drinking) water - estimated normal consumption 315m^3/day

By taking into account several factors such as the expected plant availability and daily variations in usage, the RP has concluded that the total annual fresh water consumption for a single reactor will be approximately 405,835m^3/yr.

We consider the fresh water requirement estimates to be reasonable for the design, and broadly similar to fresh water requirements at other similar nuclear power stations. We will encourage a future operator to continually monitor and minimise fresh water usage throughout the life cycle of the facility.

13.2. Cooling water requirements

Information on cooling water is provided in the RP's Pre-Construction Environmental Report (PCER) on Conventional Impact Assessment' (GNSL, 2021w).

The RP states that the generic site being considered for GDA is a coastal or estuary site. An abstraction licence would not be required if cooling water is abstracted from open coastal waters, but it is likely to be required if an estuary location is chosen.

Cooling water is used in 3 systems in the UK HPR1000 design:

- Circulating water system - this system supplies cooling water to the turbine condenser and the auxiliary cooling water system. The water is abstracted from the environment, used to cool the heat exchanger equipment and then discharged back into the environment.
- Essential service water system - this system uses abstracted water to cool the heat exchanger in the component cooling water system and then discharge it back into the environment.
- Auxiliary cooling water system - this system takes some water from the main circulating water system to supply the conventional island closed cooling water system coolers and the condensate vacuum system coolers before discharging it back into the environment.

The RP has concluded that it considers a once-through cooling system to be the most appropriate environmental option for the UK HPR1000 design, based on the generic site characteristics (coastal or estuarine site). The RP has made it clear that other cooling system options are available for consideration at the site-specific stage depending on site-specific characteristics, including ecology and biodiversity. A future operator will need to justify the decision to use a once-through system or an alternative type of cooling system at the site-specific stage in order to demonstrate that it is the best available technique (BAT). We consider the following Assessment Finding appropriate to ensure this happens:

Assessment Finding 38: A future operator shall ensure that the siting of the cooling water intake and outlets are BAT for the UK HPR1000 design at each specific site.

The 3 cooling water systems will discharge water at a higher temperature than the receiving waters. The quantity and temperature rise figures the RP presented are similar to other reactor designs that have been subject to the GDA process and to existing operational nuclear power stations in the UK.

The abstracted sea water needs screening to remove debris before it can be used. However, screens can trap and damage fish and other invertebrates, so fish deterrent and return systems may be needed. Operators abstracting more than $20m^3$/day or discharging water back to any channel, sea or bed are subject to the requirements of the Eels (England and Wales) Regulations 2009 and must screen the abstraction or discharge to prevent eels becoming trapped, unless an exemption notice has been granted.

The RP in its 'Conventional Impact Assessment' (GNSL, 2021w) submission has described the different types of screens that could be used in the UK HPR1000 design, along with the other types of barriers and techniques for capturing and returning fish and eels back to the environment. The location of cooling water abstraction intakes and the design options to minimise fish ingress and injury to meet the requirements of the Eels Regulations 2009 depend greatly on the local environment. It is, therefore, reasonable to conclude that this can only be determined at the site-specific stage.

13.3. Our overall conclusions on water abstraction

Our conclusions are that:

- an abstraction licence would not be required for fresh water supply (for example, process and drinking water) if it is provided by a local water company
- an abstraction licence would not be required if cooling water is abstracted from open coastal waters, but it is likely to be required if an estuary location is chosen
- the choice of once-through sea water cooling could be considered appropriate for the UK HPR1000 based on a coastal or estuary location. However, other options can be considered at the site-specific stage depending on site-specific characteristics, including ecology and biodiversity
- the final design of the abstraction intake and fish deterrent and return systems for the UK HPR1000 to minimise fish ingress and injury and meet the requirements of the Eels (England and Wales) Regulations 2009 is a site-specific issue and can only be determined once the local environmental conditions are known

We have identified no potential GDA Issues and 2 Assessment Findings, as set out in the above paragraphs.

More details of our assessment of water use and abstraction can be found in our assessment report AR08 - Other environmental regulations for the UK HPR1000 design (Environment Agency, 2022h).

14. Discharges to surface waters and groundwater

This chapter covers our assessment of discharges of non-radioactive contaminants to surface waters (for example, lakes, rivers and the sea) and groundwater.

Non-radioactive contaminants include the heat transferred to the cooling water, as well as process wastes and other polluting matter. We assess the environmental impact of the discharges by comparing the predicted concentrations of contaminants in the receiving waters against relevant environmental standards. The thermal impact of the cooling water discharges is assessed in detail at the site-specific stage.

The outcome from our assessment is reported in sections 4 and 5 of our final detailed assessment report: AR08 – Other environmental regulations for the UK HPR1000 design (Environment Agency, 2022h). In summary, the outline of our assessment and our Assessment Findings is as follows.

14.1. Discharges to surface waters

Information on discharges to surface waters is provided in the RP's Pre-Construction Environmental Report (PCER) on Conventional Impact Assessment' (GNSL, 2021w).

The liquid effluent management systems in the UK HPR1000 design are quite complex, but can be simplified by considering 3 main types of liquid effluents associated with:

- radioactive waste streams
- non-radioactive waste streams
- the cooling water systems

The environmental impact in terms of the physical and chemical composition of these 3 effluent streams would be controlled by a water discharge activity permit granted under the Environmental Permitting Regulations 2016, which would be required to operate the reactor.

14.1.1. Effluents associated with radioactive waste streams

In the UK HPR1000 design liquid radioactive effluents are categorised as:

- process drains - characterised by a low level of chemical impurities
- chemical drains - characterised by a higher level of chemical impurities
- floor drains - characterised as being typically high in suspended solids
- laundry drains - characterised as being typically high in suspended solids and detergents

These effluent streams are managed and treated separately up to the point at which they enter the Nuclear Island Liquid Waste Discharge System (NLWDS) - see Figure 14-1 below. Treatment of these effluent streams takes place in the Liquid Waste Treatment

System (LWTS). The process drain effluents are treated by demineralisation, chemical drain effluents are treated by evaporation, and the floor and laundry drains are treated by filtration. The treatment options for these effluents are intended to treat radioactive as well as chemical contaminants.

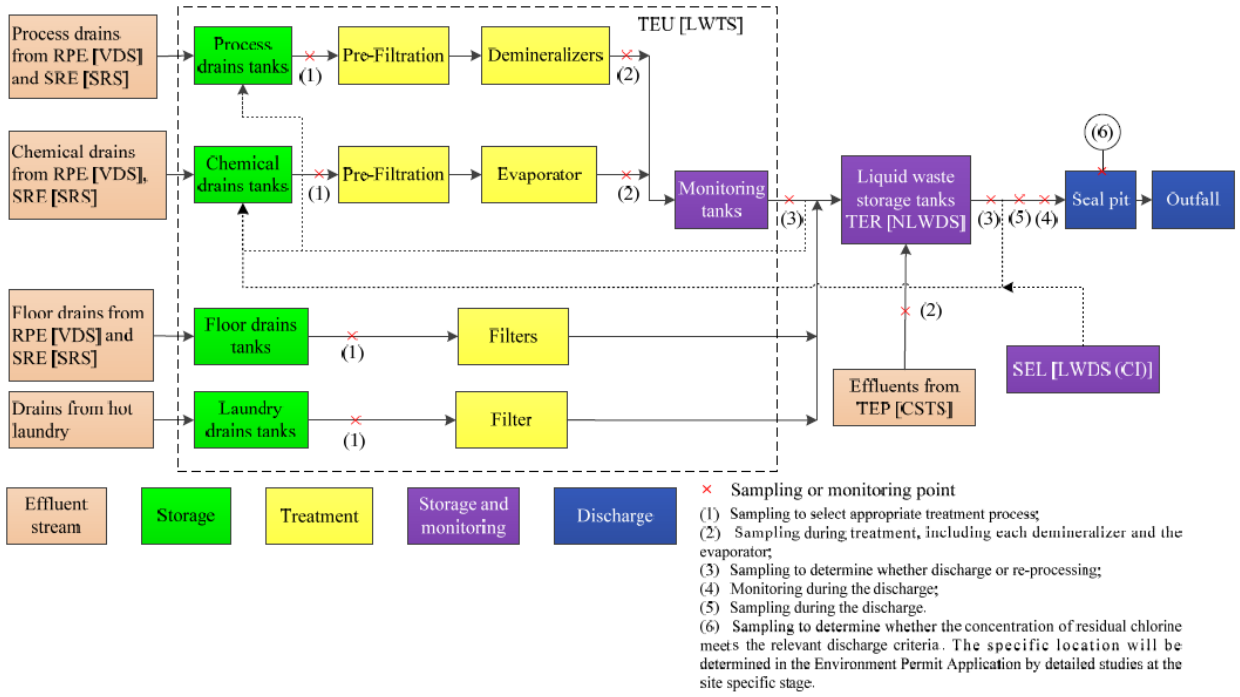

Figure 14-1: Flow diagram for liquid radioactive effluent streams (GNSL, 2021w)

System abbreviations used in Figure 14-1 are as follows:

- RPE[VDS], nuclear island vent and drain system
- SEL[LWDS(CI)], conventional island liquid waste discharge system
- SRE[SRS], sewage recovery system
- TEP[CSTS], coolant storage and treatment system
- TER[NLWDS], nuclear island liquid waste discharge system
- TEU[LWTS], liquid waste treatment system

Figure 14-2 shows the systems that are used to manage potentially radioactive effluents from the turbine hall (Waste Fluid Collection System for Conventional Island - WFCSCI) and Steam Generator Blowdown System (SGBS) before they go to the Conventional Island Liquid Waste Discharge System (LWDS(CI)). The turbine hall effluents also have the potential to be oily so the WFCSCI is split into 2 parts: part 1 treats the potentially oily wastes, while part 2 deals with the non-oily effluents. The potentially radioactive, oily effluents are treated by conventional oil/water separation techniques, which remove the oil fraction from the effluent stream, and are then dealt with separately by off-site recovery or disposal. The remaining water fraction is sampled in storage tanks in the LWDS(CI) and then either released for discharge via the seal pit or directed to the appropriate treatment facility in the LWTS (see Figures 14-1 and 14-2). The seal pit is a structure designed to prevent air getting back into the cooling water and effluent systems and is linked to the main site outfall into the environment.

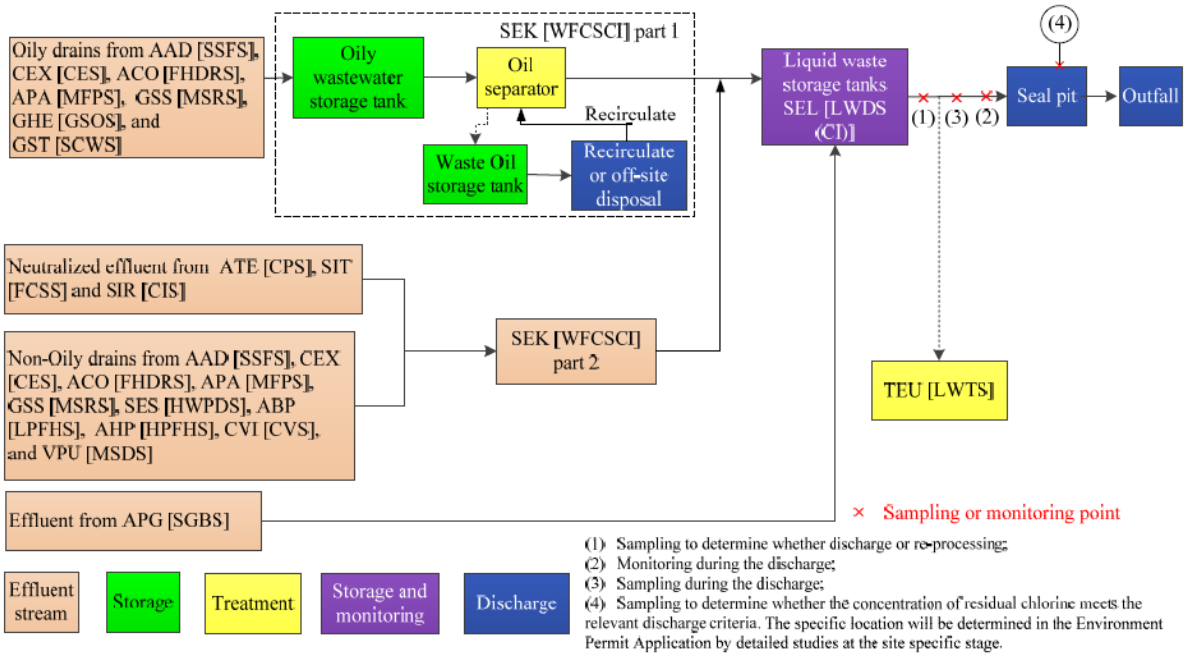

Figure 14-2: Flow diagram for potentially radioactive effluent streams (GNSL, 2021w)

System abbreviations used in Figure 14-2 are as follows:

- AAD[SSFS], Start-up and shutdown feedwater system
- ABP[LPFHS], Low pressure feedwater heater system
- ACO[FHDRS, feedwater heater drain recovery system
- AHP[HPFHS], high pressure feedwater heater system
- APA[MFPS], motor driven feedwater pump system
- APG[SGBS], steam generator blowdown system
- ATE[CPS], condensate polishing system
- CEX[CES], condensate extraction system
- GHE[GSOS], generator seal oil system
- GSS[MSRS], moisture separator reheater system
- GST[SCWS], stator cooling water system
- SEK[WFCSCI], waste fluid collection system for conventional island
- SEL[LWDS(CI)], conventional island liquid waste discharge system
- SES[HWPDS], hot water production and distribution system
- SIR[CIS], chemical reagents injection system
- SIT[FCSS], feedwater chemical sampling system
- TEU[LWTS], liquid waste treatment system
- VPU[MSDS], main steam and drainage system for CI

The RP developed a structured process to identify all chemicals that are likely be used in the UK HPR1000 design, to identify the route each substance will take through the plant

and then to derive discharge estimates in terms of an average and maximum annual load (in kg). These estimates were then used for the environmental impact assessment (see 'environmental impact assessment' below). This chemical emission inventory (GNSL, 2019c) covered the routes shown in Figures 14-1 and 14-2 above and the cooling water system. The estimates were developed by using OPEX from similar operational nuclear power stations.

The estimated discharges obtained for the UK HPR1000 were then compared with French and Chinese PWR fleets as well as the UK European pressurised reactor (UK EPR) design data. The results for all chemicals assessed, apart from hydrazine, show that discharges are comparable to the Chinese and French fleets and the UK EPR. The RP explained that this difference in hydrazine discharges could be due to the assumption in GDA that hydrazine will not be treated before discharge, whereas it is in the French fleet and the UK EPR. The RP considers that the discharge estimates for hydrazine could be reduced by a future operator at the site-specific stage by applying treatment techniques. In order to ensure this is highlighted as an outcome from GDA, we have raised the following Assessment Finding, which also ensures refinement of the calculation of chemical emissions at a site-specific stage:

Assessment Finding 39: A future operator shall review the calculations for emissions of chemicals as part of the site-specific environmental risk assessment. Particular attention should be focussed on the application of possible treatment techniques for hydrazine to reduce the amount discharged to the environment and arrangements to minimise any impact.

Subject to the Assessment Finding above, we are satisfied that the RP's conclusions for this aspect of the design meet our expectations for GDA.

14.1.2. Effluents associated with non-radioactive waste streams

There are 3 effluent management systems for non-radioactive waste streams in the UK HPR1000 design:

- station sewer system (SSS) Part 1
- station sewer system (SSS) Part 2
- waste oil and non-radioactive water drainage system (WONWDS)

These 3 systems have been classed as out of scope of GDA but the RP has provided some basic information on each in its ‘Pre-Construction Environmental Report (PCER) on Conventional Impact Assessment' (GNSL, 2021w).

The station sewer system part 1 accepts effluents from the non-radioactive parts of the nuclear island (for example, air conditioning systems and ventilation systems) as well as domestic sewage from a number of buildings.

The station sewer system part 2 collects site surface rainwater, roof water and uncontaminated waste released from the circulating water system among other non-radioactive systems.

The waste oil and non-radioactive water drainage system collects all the non-radioactive oily water from various sources.

These 3 systems are out of scope of GDA and can all be independently discharged directly into the environment. It is essential that a future operator focuses on the site-specific design of these systems as this has not been addressed at GDA. So, we have raised the following Assessment Finding:

Assessment Finding 40: A future operator shall ensure that the storage, treatment and monitoring systems for the 3 non-radioactive effluent streams provide the appropriate level of environmental protection for the receiving environment in terms of quality of effluent discharged. This would be regulated by a water discharge activity permit.

We are unable to provide any definitive conclusions on this aspect of the design as it is out of scope of GDA and the majority of the decision-making has been left to the site-specific stage.

14.1.3. Effluents associated with cooling water systems

The cooling water system comprises 3 systems: the circulating water system, essential service water system and the auxiliary cooling water system. These systems are described in section 13 above in the context of water abstraction and use. When the water has been used to cool the various components of the design it will need to be discharged back into the environment under the terms of a water discharge activity permit. This assessment is based on the once-through cooling water system the RP proposed for GDA. If an alternative cooling water technique is chosen at the site-specific stage, then this will need to be reassessed at that time.

In order to prevent biofouling of the internal systems, the abstracted cooling water is dosed with a biocide. The RP has stated that the final dosing strategy is a site-specific matter for a future operator to decide. For the purposes of GDA, the RP has assumed sodium hypochlorite will be used as the biocide and has carried out the environmental impact assessment based on this. The RP has, however, stated that whatever strategy is chosen, the residual chlorine (from the sodium hypochlorite) will be in the range of 0.1mg/l to 0.5mg/l, with a daily average of 0.2mg/l. These estimated values have been carried forward to the environmental impact assessment (see 'environmental impact assessment' below).

The thermal impact of the cooling water discharge is considered to be highly site-specific and has therefore been agreed as out of scope of this GDA.

In common with similar types of power stations, there is no treatment of the cooling water prior to discharge. The 3 cooling water systems are directed to the seal pit where some mixing with the effluents associated with radioactive waste streams will occur as it discharges to the environment via the main site outfall.

14.1.4. Environmental impact assessment

Despite much of the above section leaving options open for a future operator to make at site-specific design stage, we asked the RP to consider the environmental impact of water discharges at the GDA stage.

We asked the RP to provide an environmental impact assessment at GDA stage to determine whether the proposed emissions from the generic design could be considered potentially acceptable at the site-specific stage. The impact assessment is necessarily generic at this stage because there are a number of aspects of the use and treatment of chemicals that are not known at the GDA stage and the specific environmental setting is also not known. Both of these elements will need to be included in more detailed site-specific modelling for the application for a water discharge activity permit. To ensure this aspect is addressed, we raised the following Assessment Finding:

Assessment Finding 41: A future operator shall provide in an application for a water discharge activity environmental permit a site-specific environmental impact assessment for discharges to water. The modelling shall use site-specific parameters based on the environmental setting and the specific chemicals selected for use.

The environmental impact assessment carried out for GDA was an initial screening assessment using our recommended H1 tool environmental risk assessment tool.

After following our guidance, one substance, hydrazine, was identified as requiring further assessment and the RP acknowledged this in its PCER (GNSL, 2021w). If the H1 tool had produced this outcome when being used at a site-specific permitting stage, then we would require the operator to carry out more detailed modelling of the specific discharge in the specific environment. We do not consider it appropriate to ask for this at GDA stage, as there would be so many assumptions that the outcomes would have a high level of uncertainty associated with them. We do, however, consider that hydrazine warrants particular attention at a site-specific stage (see Assessment Finding 39).

The risk assessment the RP carried out is sufficient for GDA, but a future operator will have to carry out a site-specific assessment for all substances, including hydrazine, to be discharged as part of its permit application. This will ensure that the assessment is carried out with site-specific environmental information on the receiving environment and with a much lower level of assumption and uncertainty in the input parameters. We consider Assessment Finding 41 (see above) appropriate to ensure this happens.

As part of the site-specific permit application, the operator will also need to consider whether there are any designated habitat sites (including Sites of Special Scientific Interest, Marine Conservation Zones, Special Protection Areas, Special Areas of Conservation or Ramsar Convention sites) in the area and, if necessary, carry out a Habitats Regulations assessment.

14.1.5. Options for beneficial use of waste heat

Nuclear power stations, like other thermal power generation processes, convert thermal energy into electrical power. It is not possible to convert 100% of the thermal energy into

electricity, therefore, there is residual heat in the cooling water that is released to the environment. In our P&ID we ask the RP to consider possible uses of the waste heat that would be compatible with the design.

The RP considers that the potential for beneficial use of waste heat is a highly site-specific matter because it depends on what potential users are situated nearby. We agree with this conclusion. However, in order to satisfy our P&ID requirement, the RP has suggested a number of ways in which the waste heat (in the form of warm water) from the UK HPR1000 could be used.

14.2. Discharges to groundwater

Information on discharges to groundwater is provided in the RPL's Pre-Construction Environmental Report (PCER) on Conventional Impact Assessment' (GNSL, 2021w). In this document, the RP confirms that there that there are no intentional discharges to groundwater.

The RP's PCER also describes the measures taken to prevent and minimise unintentional discharges to groundwater.

The RP states that the site infrastructure will be designed to prevent the release of contaminated water to soil and groundwater. This will be based on site-specific credible accident scenarios and will be in line with relevant guidance and legislation. The design requirements will include, but not be limited to:

- primary containment design (tanks)
- secondary containment design (bunds)
- tertiary containment systems (hardstanding linked to the drainage systems)
- firewater containment systems

The RP states that the following measures will also be implemented:

- provision of spill kits
- management arrangements, including staff training (deliveries, spill prevention and response)

The detailed site layout design can only be determined at the site-specific stage, therefore the exact arrangements for drainage, secondary and tertiary containment are not known at GDA.

We accept, for the purposes of GDA, that these measures are relevant good practice, and expect these to be incorporated into the management system and implemented before operations begin on any specific site.

We regulate these types of environmental protection systems under a number of regimes (EPR16, COMAH pollution prevention advice), so we will be able to ensure they are implemented properly at the site-specific stage.

14.3. Our overall conclusions on discharges to surface waters and groundwater

Following our assessment of the surface water discharges, our conclusions are that:

- the UK HPR1000 will have non-radioactive discharges to surface water and will require an environmental permit for a water discharge activity
- The information the RP provided for GDA is sufficient for us to conclude that the impact from discharges to surface waters could be at levels low enough to enable a reasonable application for a water discharge activity permit. However, the risk assessment work carried out for GDA must be revised with greater detail at the site-specific permitting stage to reduce the level of uncertainty that exists in the work carried out to date. At the site-specific stage, all necessary permissions must be applied for and obtained by the future operator.

Following our assessment of discharges to groundwater, our conclusions are that:

- there should be no intentional discharges to groundwater, and an environmental permit for a groundwater activity will not be required
- the pollution prevention techniques specified in the design should prevent contamination of groundwater. If any of the generic design assumptions change at a site-specific stage, then this conclusion will need to be reconsidered

We have identified no potential GDA Issues and 3 Assessment Findings, as set out above.

More details of our assessment of discharges to surface waters and groundwater can be found in our assessment report AR08 - Other environmental regulations for the UK HPR1000 design (Environment Agency, 2022h).

15. Operation of installations

This chapter covers our assessment of installations (as defined in Schedule 1 to EPR16). Most nuclear power station designs include conventional combustion plant of sufficient capacity to require permitting for standby generation and/or use as auxiliary boilers. Other ancillary plant may also meet a description in Schedule 1 to EPR16 and require permitting.

The outcome from our assessment is reported in section 6 of our final detailed assessment report: AR08 – Other environmental regulations for the UK HPR1000 design (Environment Agency, 2022h). In summary, the outline of our assessment is as follows.

15.1. Identifying installations

Information on the operation of installations is provided in the RP's ‘Pre-Construction Environmental Report (PCER) on Conventional Impact Assessment' (GNSL, 2021w).

15.1.1. Combustion plant

The conventional combustion plant is specified in the RP's ‘Pre-Construction Environmental Report (PCER) on Conventional Impact Assessment' (GNSL, 2021w). It will consist of:

- 3 fixed emergency diesel generators (EDGs), each with a thermal input of 19.45MW to supply 8MWe of electricity
- 2 fixed station blackout diesel generators (SBO DGs), each with a thermal input of 8.27MW to supply 3.1MWe of electricity
- 2 mobile diesel generators (DGs). One with a thermal input of 6MWth to supply 2.1MWe of electricity, the other with a thermal input of 1.14MWth to supply 0.4MWe of electricity
- one smaller emergency security diesel generator (ESDG) with a rated thermal input of 0.82MWth to supply 0.32MWe of electricity
- one smaller diesel generator (DG) with a rated thermal input of 0.82MWth to supply 0.32MWe of electricity

The RP has considered the 2 smaller generators as out of scope of GDA and, due to their relatively small size, we agree with this conclusion. The 2 mobile generators have been added to the design since we published our consultation document (Environment Agency, 2021a). In our consultation document, we noted that further work was being carried out to address some uncertainty over the power requirements for some aspects of the design. The addition of these 2 mobile generators is the outcome of that work. In the PCER (GNSL, 2021w), the RP states that it will not be revising the existing impact assessments for discharges to air. This is because the 2 mobile generators can never operate simultaneously with the EDGs and SBO DGs, and, because they are a smaller capacity, any impact will be less than any scenario already assessed. We agree that this rationale seems reasonable and accept the impact assessments as being appropriate for this GDA. However, all combustion plant will need to be assessed for individual and in-combination

environmental impacts at each site-specific permitting stage (see also Assessment Finding 43 below).

The following assessment applies to the 3 EDGs and 2 SBO DGs.

As the total thermal input of the combustion plant exceeds 50MWth, it is a Part A(1) installation as described in section 1.1 of chapter 1 in part 2 of Schedule 1 in EPR16. This means that it will require an environmental permit from the Environment Agency.

As the total thermal input exceeds 20MWth, the combustion plant is also a 'regulated activity' as defined in GGETSR12 and will require a greenhouse gas emissions permit under those regulations (UK Parliament, 2020).

15.1.2. Other ancillary plant

In general, the only other ancillary plant found on a nuclear power station that might need a permit under EPR16 would be any on-site waste incinerator. The submission confirms in the ‘Pre-Construction Environmental Report (PCER) on Conventional Impact Assessment' (GNSL, 2021w) that the design does not include an on-site incinerator.

15.2. Combustion plant operations

The 3 EDGs are classed as nuclear safety equipment. They are included in the design to provide back-up power to the equipment related to the safe shutdown of the reactor and its maintenance in a safe condition in the event of a loss of off-site power supply. The EDGs are required to start up quickly and automatically in the event of a loss of off-site power. The back-up generators would also provide power to important plant, providing environment protection functions in this circumstance.

The 2 SBO DGs are also classed as nuclear safety equipment. They are included in the design to provide power to nuclear safety related equipment in the event of a station black-out condition (loss of off-site and on-site power).

The RP states that the final selection of the combustion plant will be carried out at the site-specific stage. This will be based on a review of suitable combustion plant available and the selection will be based on the assessment of BAT.

In accordance with our P&ID requirements, the RP carried out a high-level comparison of the proposed combustion technology against the Environment Agency Combustion Sector Guidance Note (Environment Agency, 2009) and relevant Environment Agency guidance on controlling and monitoring emissions for an environmental permit (Environment Agency, 2020b). The combustion sector note was withdrawn during the course of this GDA (on 24 August 2018), but due to the high-level nature of the assessment at GDA stage, the comparison still stands. A future operator will need to carry out a more detailed BAT assessment at the site-specific permitting stage, so we consider the following Assessment Finding to be appropriate:

Assessment Finding 42: A future operator shall provide in an application for an environmental permit a BAT assessment of the specific combustion plant selected for use against the relevant BAT guidance at the time of application.

The BAT assessment the RP provided for this GDA covers all the relevant topic areas we would expect to see for a proposed combustion plant, which include energy efficiency, operational issues, point source emissions to water, point source emissions to air, fugitive emissions, monitoring and avoiding, recovering and disposing of wastes.

Overall, acknowledging the generic nature of any BAT assessment carried out at GDA stage, which is mainly due to the specific plant and environmental setting of the site being unknown, we consider the assessment the RP has included in its submission to be acceptable and meets our expectations for GDA.

15.2.1. Environmental impact assessment

We asked the RP to provide an environmental impact assessment in GDA to determine whether the proposed emissions from the generic design can be considered reasonable at the site-specific stage. The impact assessment is generic at this stage because the specific combustion plant and the environmental setting are not known. Both of these elements will need to be included in more detailed site-specific modelling for the application for an installation activity environmental permit.

The environmental impact assessment carried out for GDA involved an initial screening assessment using our recommended H1 tool. The purpose of the initial screening assessment was to assess the ground level concentrations of the combustion plant emissions against the applicable relevant short-term and long-term air quality standards. The assessment was based on the operation of a single EDG or SBO DG operating separately. This is considered acceptable because the assessment only applies to commissioning and testing which are both planned activities.

The risk assessment the RP carried out is sufficient for GDA, but a future operator will have to carry out site-specific air dispersion modelling as part of the permit application to demonstrate compliance with air quality standards and to demonstrate that the environmental impact from the combustion plant installation is acceptable. We consider the following Assessment Finding appropriate to ensure this happens:

Assessment Finding 43: A future operator shall provide, in an application for a combustion activity environmental permit a site-specific environmental impact assessment for discharges to air. The modelling shall use site-specific parameters based on the environmental setting and the specific combustion plant selected for use.

As part of the site-specific permit application, the operator will also need to consider whether there are any designated habitat sites (including Sites of Special Scientific Interest, Marine Conservation Zones, Special Protection Areas, Special Areas of Conservation or Ramsar Convention sites) in the area and, if necessary, carry out a Habitats Regulations assessment.

15.2.2. Medium combustion plant

Consideration of legal requirements relating to medium combustion plant, (MCP) (UK Parliament, 2018) is not currently included in our P&ID because they are relatively new. We raised this with the RP and asked it to consider how MCP requirements would apply to its proposed generators.

The MCP requirements apply to all combustion plant between 1 and 50MW, so all the generators will be classed as medium combustion plant. They will need to be permitted as such, and this is likely to be as part of the installation environmental permit. The legislation does provide a threshold of 500 hours a year under which the emission limits do not apply. However, a permit will be required, and the permit will still include monitoring requirements for certain parameters (for example, carbon monoxide and oxides of nitrogen). This will mean that suitable monitoring infrastructure will need to be designed into each generator to enable safe and accurate monitoring to be carried out.

15.3. Combustion plant - greenhouse gas emissions

The UK HPR1000 combustion plant will require a permit from us under the Greenhouse Gas Emissions Trading Scheme Order 2020 (the Order), as the total rated thermal input of combustion units operated on the site exceeds the 20MW threshold set out in the Order.

The RP states that the proposed approach to monitoring greenhouse gas emissions will meet the requirements of the Monitoring and Reporting Regulation (MRR) (Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council) as amended by the Order (the MRR). The RP states that it will follow the standard method used for calculating emissions as outlined in the MRR. The standard method involves measuring fuel and process inputs and applying appropriate calculation factors (such as emission and oxidation factors and net calorific values) to calculate the total emissions.

We accept, for the purposes of GDA, that the RP has provided sufficient information on greenhouse gas monitoring.

We will continue to assess this aspect as part of our site-specific regulatory activities.

15.4. Our overall conclusions on operation of installations

Our conclusions are that:

- the UK HPR1000 combustion plant (diesel generators) is likely to be a Part A(1) installation as described in section 1.1 of chapter 1 in part 2 of Schedule 1 of The Environmental Permitting (England and Wales) Regulations 2016 and will, therefore, require an environmental permit from the Environment Agency
- several aspects of the GDA submission will need to be revised and updated when site-specific data are available. The main aspects that will need considering further are:

- a BAT assessment for the chosen diesel generators
- the application of the legal requirements for medium combustion plant. This may require the necessary monitoring infrastructure to be included in the design (that is, in line with technical guidance note M1 (Environment Agency, 2017b))
- site-specific modelling to demonstrate compliance with air quality objectives
- the UK HPR1000 combustion plant will also require a permit under the Greenhouse Gas Emissions Trading Scheme Order 2020 (UK Parliament, 2020)

We have identified no potential GDA Issues and 2 Assessment Findings, as set out above.

More details of our assessment of operation of installations can be found in our assessment report AR08 - Other environmental regulations for the UK HPR1000 design (Environment Agency, 2022h).

16. Control of major accident hazards

This chapter covers our assessment of the applicability and requirements of the Control of Major Accident Hazards (COMAH) Regulations 2015 for the UK HPR1000 design. Nuclear power stations may need to store one or more dangerous substances (as defined in the COMAH Regulations) in quantities at which the regulations apply, in which case, precautions to prevent a major accident to the environment need to be considered.

The outcome from our assessment is reported in section 7 of our final detailed assessment report: AR08 – Other environmental regulations for the UK HPR1000 design (Environment Agency, 2022h). In summary, the outline of our assessment is as follows.

16.1. Dangerous substances

It is worth noting an important aspect of the RP's COMAH assessment. The GDA scope considers a single unit, but in order for the COMAH assessment to be more meaningful, the RP agreed at an early stage in the GDA process to consider 2 units for the COMAH assessment, as it is more usual to deploy nuclear power stations in pairs. Under COMAH, threshold quantities of dangerous substances need to be exceeded in order for the regulations to apply. Considering 2 units at the GDA stage ensures that any design modifications required to comply with the COMAH Regulations are not missed by assessing one unit in isolation. We welcome this approach to the COMAH assessment carried out for this GDA.

The RP developed a process to assess each chemical for the applicability of the COMAH Regulations. The process can be summarised as follows:

- step 1 - develop an inventory of chemicals
- step 2 - classify the dangerous substances according to the GB Classification, Labelling and Packaging Regulation (https://www.hse.gov.uk/chemical-classification/legal/clp-regulation.htm) and identify the corresponding qualifying thresholds in the COMAH Regulations
- step 3 - carry out the comparison against upper and lower tier thresholds provided in the COMAH Regulations. The COMAH Regulations are set out in such a way that a site (or 'establishment' as defined by the regulations) can be classed as either upper tier or lower tier depending on the quantities of dangerous substances present
- step 4 - application of the 'aggregation rule' and '2% rule'. Both of these rules are provided by the COMAH Regulations

We consider the RP's approach to be appropriate.

The chemical inventory has been based on operational experience from the wider China General Nuclear (CGN) fleet of nuclear power stations. The RP has presented an inventory of chemicals with corresponding concentrations, how each will be used, and the

maximum storage quantities. Two separate inventories have been presented at GDA, one for commissioning and one for the operational phase of the plant's life cycle.

The inventories were then used to carry out a range of assessments to cover 3 different scenarios:

- 2 units under commissioning
- one unit under commissioning and one unit in operation
- 2 units in operation

We consider this scenario-based approach to be acceptable as it should ensure that the expected changes in the inventory during the early phases of plant life are considered in this assessment.

Our assessment found that the RP had applied the aggregation rule correctly.

The 2% states that any dangerous substance present in quantities less than 2% of the appropriate threshold (identified in step 2 above) can be excluded from the COMAH assessment as long as its location prevents it from initiating a major accident. Because the location of each dangerous substance is not known at GDA, the 2% rule could not be applied at this stage. The assessment is therefore applied to the whole of the proposed inventory.

Having followed the procedure outlined above, the RP concludes that the UK HPR1000 will not be subject to the COMAH Regulations during the commissioning and operational phases of the plant’s life cycle. Construction and decommissioning phases have been agreed as being out of scope of GDA.

We can accept the RP's findings based on the level of detail known at GDA stage. It is, however, important to note that as a site-specific design develops, the proposed chemical inventory may change. We therefore consider the following Assessment Finding to be appropriate:

Assessment Finding 44: A future operator shall keep the chemical inventories on its site under review so any applicability of COMAH can be identified early and the necessary major accident prevention measures can be installed.

16.2. Measures to prevent a major accident to the environment

Despite the outcome of the assessment being that the UK HPR1000 is unlikely to be subject to the COMAH Regulations, the RP has fulfilled the P&ID requirement to describe the measures it could use to prevent a major accident to the environment (MATTE) should the inventory (and therefore COMAH assessment) change at the site-specific stage. We welcome this approach as it ensures that future detailed design and layout of the site considers COMAH.

The measures that could be used are summarised in the ‘Pre-Construction Environmental Report on Conventional Impact Assessment' (GNSL, 2021w) and include the main aspects

of primary (tanks and pipework), secondary (bunds) and tertiary (kerbed hardstanding and drainage systems) containment systems.

The level of detail the RP presented in its submission is considered sufficient to demonstrate an awareness at the GDA stage.

16.3. Our overall conclusions on substances subject to the control of major accident hazards

Our conclusions are that:

- the UK HPR1000 is unlikely to be subject to the Control of Major Accident Hazards (COMAH) Regulations
- changes in inventory at the site-specific stage need to be kept under review to ensure a relevant threshold for the COMAH Regulations is not exceeded. If any of the generic design assumptions change at a site-specific stage, then this conclusion will need to be reconsidered

We have identified no potential GDA Issues and one Assessment Finding, as set out in the above paragraphs.

More details of our assessment of the control of major accident hazards can be found in our assessment report AR08 - Other environmental regulations for the UK HPR1000 design (Environment Agency, 2022h).

It should be noted that the above preliminary conclusion relates only to major accidents to the environment. Our partner in the competent authority for COMAH regulation, ONR, is responsible for assessing matters relating to impacts on people.

17. Fluorinated greenhouse gases and ozone depleting substances

This chapter covers our assessment of the use of fluorinated greenhouse gases (F-gases) and ozone-depleting substances in the UK HPR1000. These gases can be used in systems such as those that provide cooling or fire protection. In this chapter the gases that would be used in the UK HPR1000 are identified and the measures taken to prevent and minimise leakage are considered.

The outcome from our assessment is reported in section 8 of our final detailed assessment report: AR08 – Other environmental regulations for the UK HPR1000 design (Environment Agency, 2022h). In summary, the outline of our assessment and our Assessment Findings is as follows.

17.1. Fluorinated greenhouse gases

A number of F-gases are currently proposed to be used in the UK HPR1000 design in the refrigeration system, fire protection system and as insulating gases. These types of uses are common in other industrial sectors in the UK. The RP has specified the list of F-gases proposed to be used in the UK HPR1000 and none of them at the quantities proposed are either banned now or are planned to be banned in the near future. They are, however, in a legislatively controlled phase down in use and therefore ultimately, alternatives will need to be sourced. The legislation controlling these gases may, however, change over timeA future operator should keep the proposed F-gases under review to ensure their continued use at the required quantities remains legally possible in England. In its Pre-Construction Environmental Report (PCER) submission the RP acknowledges this and presents some possible alternatives for future use. The RP concludes that the final choice of F-gases to be used in the UK HPR1000 is a site-specific matter for a future operator. We consider the RP's proposals and conclusion to be acceptable for GDA. In order to ensure the extent of the GDA assessment is carried through into the site-specific stage, we consider the following Assessment Finding to be appropriate:

Assessment Finding 45: A future operator shall keep the fluorinated greenhouse gases proposed for use in the UK HPR1000 under review to ensure they continue to be legally acceptable for use.

Where these gases are included in the design, the RP must describe the measures proposed to prevent and minimise leakage of such substances. The RP outlines the proposed measures for each proposed use. Despite being at a very high level in the PCER submission, it is considered acceptable for GDA due to the site-specific nature of such decisions.

17.2. Ozone-depleting substances

The RP confirms in its ‘Pre-Construction Environmental Report (PCER) on Conventional Impact Assessment' (GNSL, 2021w) that no ozone depleting substances will be used in the UK HPR1000 design.

17.3. Our overall conclusions on fluorinated greenhouse gases and ozone-depleting substances

Our conclusions are that:

- no ozone-depleting substances are proposed to be used in the design
- the proposed quantities of specific fluorinated greenhouse gases to be used in the design are currently acceptable under the relevant legislation and in common with current UK practice
- the level of detail in the proposed measures to prevent and minimise leakage is considered acceptable for GDA

We have identified no potential GDA Issues and one Assessment Finding, as set out in the above paragraphs.

More details of our assessment of fluorinated greenhouse gases and ozone-depleting substances can be found in our assessment report AR08 - Other environmental regulations for the UK HPR1000 design (Environment Agency, 2022h).

18. Our overall conclusion

Section 12 summarises our conclusion relating to radioactive substances permitting. This notes that, subject to the Assessment Findings identified in Chapters 5 to 11, the design would acceptable for permitting for the disposal of radioactive waste at any coastal site consistent with the generic site as defined by the RP. The characteristics of this generic site envelop the sites included in the national nuclear policy statement, EN-6 (DECC, 2011b and 2011c), but detailed assessments specific for any proposed site would be required as part of application.

We do not believe that any of the Assessment Findings are so fundamental that they are unlikely to be resolved satisfactorily during site-specific permitting or post permitting work.

Similarly, sections 13 to 17 summarise our assessment relating to other environmental regulations:

- water use and abstraction
- water discharge activities (discharges to surface and groundwater)
- operation of installations
- COMAH
- F-gases and ozone depleting substances.

Subject to the Assessment Findings identified in Chapters 13 to 17, the design may be acceptable for permitting at any coastal site consistent with the generic site as defined by the RP. The characteristics of this generic site envelop the sites included in the national nuclear policy statement, EN-6 (DECC, 2011b and 2011c), but detailed assessments specific for any proposed site would be required as part of application. Noting that the assessments in Chapters 13 to 17 cannot carried out to the same detail as those for radioactive substances permitting, because complex site specific modelling or site-specific information is required, we cannot be as definitive. However, we haven't found anything that would prohibit deployment.

We do not believe that any of the Assessment Findings are so fundamental that they are unlikely to be resolved satisfactorily during site-specific permitting or post permitting work.

We have also considered whether the additional information received since our consultation has significantly changed the basis of our consultation. We believe that there have been no changes to the design or submissions that would impact on the information presented at consultation.

Our overall conclusion is that we can issue a statement of design acceptability (SoDA) for the UK HPR1000. This is valid only for a site meeting the identified generic site characteristics and subject to any future determination of a site-specific permit application.

This statement is provided as advice to the Requesting Party, under Section 37 of the Environment Act 1995. It does not guarantee that any site-specific applications for environmental permits for the UK HPR1000 will be successful.

19. References

Beresford, N., Brown, J., Copplestone, D., Garnier-Laplace, J., Howard, B., Larsson, C.M., Oughton, D., Pröhl, G. AND Zinger, I. 2007.

D-ERICA: An integrated approach to the assessment and management of environmental risks of ionising radiation. Description of purpose, methodology and application. European Commission Community Research Contract Number FI6R-CTerrestrial-2004-508847.

BEIS, 2020,

Department for Business, Energy & Industrial Strategy: Energy white paper: Powering our net zero future

https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future

BEIS, 2018.

Implementing Geological Disposal - Working with Communities: An updated framework for the long-term management of higher activity radioactive waste. December 2018.

DECC, 2014.

Implementing Geological Disposal, A Framework for the long-term management of higher activity radioactive waste. 2014.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332890/GDF_White_Paper_FINAL.pdf

DECC, 2011a.

Overarching National Policy Statement for Energy (EN-1)

https://www.gov.uk/government/publications/national-policy-statements-for-energy-infrastructure

DECC, 2011b.

National Policy Statement for Nuclear Power Generation (EN-6): Annexes - volume I of II

https://www.gov.uk/government/publications/national-policy-statements-for-energy-infrastructure

DECC, 2011c.

National Policy Statement for Nuclear Power Generation (EN-6): Annexes - volume II of II https://www.gov.uk/government/publications/national-policy-statements-for-energy-infrastructure

DECC, 2011d.

Funded Decommissioning Programme Guidance for New Nuclear Power Stations

3797-guidance-funded-decommissioning-programme-consult.pdf (publishing.service.gov.uk)

DECC, 2009a.

Statutory Guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment. Department of Energy and Climate Change and Welsh Assembly Government, 2009.

DECC, 2009b.

UK Strategy for Radioactive Discharges. Department of Energy and Climate Change, the Scottish Government, Welsh Assembly Government, and Department of the Environment (Northern Ireland), July 2009. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249884/uk_strategy_for_radioactive_discharges.pdf

Environment Agency, 2022a.

Assessing new nuclear power station designs. Generic design assessment of the UK HPR1000. Management systems for the UK HPR1000 design. AR01, January 2022.

Environment Agency, 2022b.

Assessing new nuclear power station designs. Generic design assessment of the UK HPR1000. Strategic considerations for radioactive waste management for the UK HPR1000 design. AR02. January 2022.

Environment Agency, 2022c.

Assessing new nuclear power station designs. Generic design assessment of the UK HPR1000. Best available techniques for the UK HPR1000. AR03. January 2022.

Environment Agency, 2022d.

Assessing new nuclear power station designs. Generic design assessment of the UK HPR1000. Gaseous and liquid discharges of radioactive waste for the UK HPR1000 design. AR04. January 2022.

Environment Agency, 2022e.

Assessing new nuclear power station designs. Generic design assessment of the UK HPR1000. Solid radioactive waste, spent fuel and disposability for the UK HPR1000 design. AR05. January 2022.

Environment Agency, 2022f.

Assessing new nuclear power station designs. Generic design assessment of the UK HPR1000. Sampling and monitoring for the UK HPR1000. AR06. January 2022.

Environment Agency, 2022g.

Assessing new nuclear power station designs. Generic design assessment of the UK HPR1000. Generic site, doses to the public and dose rates to wildlife for the UK HPR1000. AR07. January 2022.

Environment Agency, 2022h.

Assessing new nuclear power station designs. Generic design assessment of the UK HPR1000. Other environmental regulations for the UK HPR1000. AR08. January 2022.

Environment Agency, 2021a.

Assessing new nuclear power station designs: Generic design assessment of General Nuclear System Limited's UK HPR1000 - Consultation document. January 2021.

https://consult.environment-agency.gov.uk/nuclear/assessing-new-nuclear-power-station-ukhpr1000/

Environment Agency, 2021b.

Independent dose assessment to support the Environment Agency's assessment of General Nuclear System Limited's UK HPR1000 https://consult.environment-agency.gov.uk/nuclear/assessing-new-nuclear-power-station-ukhpr1000/

Environment Agency, 2020a.

Corporate report: Scrutiny of RWM's work on geological disposal - annual report 2019 to 2020

https://www.gov.uk/government/publications/geological-disposal-scrutiny-of-rwms-work-annual-reports/regulatory-scrutiny-and-engagement-for-geological-disposal-annual-report-2019-to-2020

Environment Agency, 2020b.

Control and monitor emissions from your environmental permit.

https://www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit

Environment Agency, 2020c.

Monitoring of radioactive discharges to atmosphere from nuclear facilities, Technical guidance LIT 14887, 2020.

Environment Agency,, 2020d.

Monitoring of radioactive discharges to water from nuclear facilities, Guidance LIT 55216, 2020.

Environment Agency, 2019.

New nuclear power plants: Generic Design Assessment guidance for Requesting Parties https://www.gov.uk/government/publications/new-nuclear-power-plants-generic-design-assessment-guidance-for-requesting-parties

Environment Agency, 2018a

Initial assessment of General Nuclear System's UK HPR1000 design: Statement of findings.

New nuclear power stations: initial assessment of General Nuclear System's UK HPR1000 design - GOV.UK (www.gov.uk)

Environment Agency, 2018b

Management of radioactive waste from decommissioning of nuclear sites: Guidance on the Requirements for Release from Radioactive Substances Regulation. Version 1. July 2018.

Environment Agency, 2016.

Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs.' Version 3, October 2016.

Assessment of candidate nuclear power plant designs - GOV.UK (www.gov.uk)

Environment Agency, 2013.

The Decommissioning of Nuclear Facilities. Version 1 2013.

Environment Agency, 2012.

Criteria for setting limits on the discharge of radioactive waste from nuclear sites. Environment Agency 2012.

https://www.gov.uk/government/publications/discharge-of-radioactive-waste-from-nuclear-sites-setting-limits

Environment Agency, 2010a.

Radioactive Substances Regulation – Environmental Principles. Version 2. April 2010.

Radioactive Substances Regulation (RSR): Environmental principles - GOV.UK (www.gov.uk)

Environment Agency, 2010b.

RSR: Principles of optimisation in the management and disposal of radioactive waste, Version 2, 2010.

RSR: Principles of optimisation - GOV.UK (www.gov.uk)

Environment Agency, 2009.

How to comply with your environmental permit - Additional guidance for Combustion Activities. (EPR1.01) (Environment Agency, 2009). https://www.gov.uk/government/publications/combustion-activities-additional-guidance

Environment Agency and others, 2012.

Principles for the Assessment of Prospective Public Doses arising from Authorised Discharges of Radioactive Waste to the Environment. (Issue 2) Environment Agency, Scottish Environment Protection Agency, Northern Ireland Environment Agency, Food Standards Agency and Health Protection Agency, 2012.

GNSL, 2021a.

Integrated Waste Strategy (IWS). GHX00100070DNFF03GN, Rev. G April 2021.

GNSL, 2021b.

Pre-Construction Environmental Report Chapter 4 - Radioactive Waste Management Arrangements. HPR/GDA/PCER/0004, Revision 002, October 2021.

GNSL, 2021c.

Preliminary Decommissioning Plan. GHX71500004DNFF03GN, Rev. G April 2021.

GNSL, 2021d.

Decommissioning Waste Management Proposal. GHX71500009DNFF03GN, Rev. F April 2021.

GNSL, 2021e.

Pre-Construction Environmental Report Chapter 3 – Demonstration of BAT, HPR/GDA/PCER/0003, Revision 002, October 2021.

GNSL, 2021f.

Minimisation of the Discharge and Environment Impact of Carbon-14, GHX00100005DOHB00GN, Revision D, May 2021.

GNSL, 2021g.

Pre-Construction Environmental Report Chapter 6 – Quantification of Discharges and Limits. HPR/GDA/PCER/0006, Revision 002, October 2021.

GNSL, 2021h.

Radioactive Waste Management Case for ILW. GHX00100066DNFF03GN, Revision E July 2021.

GNSL, 2021i.

Radioactive Waste Management Case for HLW. GHX00100065DNFF03GN, Revision E, July 2021.

GNSL, 2021j.

Pre-Construction Environmental Report Chapter 5 - Approach to Sampling and Monitoring. HPR/GDA/PCER/0005, Version 2, October 2021.

GNSL, 2021k.

Conceptual Proposal of ILW Interim Storage Facility. GHX00100063DNFF03GN, Revision E, March 2021.

GNSL, 2021l.

Preliminary Safety Evaluation of Spent Fuel Interim Storage. GHX00100046DNFP03GN, Revision H, May 2021.

GNSL, 2021m.

Pre-Construction Safety Case, Chapter 29 - Interim storage of Spent Fuel. HPR/GDA/PCSR/0029, Version 2, October 2021.

GNSL, 2021n.

Spent Fuel Interim Storage Facility Design. GHX00100081DNFF03GN, Revision H, May 2021.

GNSL, 2021p.

Management Proposal of Waste Non-Fuel Core Components. GHX00100064DNFF03GN, Revision F, January 2021.

GNSL, 2021q.

GDA: Disposability Assessment for Wastes and Spent Fuel arising from Operation and Decommissioning of the UK HPR1000 – Part 1 Main Report. Doc No. LL/33574727, March 2021.

GNSL, 2021r.

GDA: Disposability Assessment for Wastes and Spent Fuel arising from Operation and Decommissioning of the UK HPR1000 – Part 2 Supporting Data. Doc No. LL/33578330, February 2021.

GNSL, 2021s.

Response to RWM Assessment Report on UK HPR1000 HAW and Spent Fuel Disposability. GHX00100098DNFF03GN, Revision A, April 2021.

GNSL, 2021t.

Pre-Construction Environmental Report Chapter 2- Generic Site Description. HPR/GDA/PCER/0002 Revision 002, October 2021.

GNSL, 2021u.

Pre-Construction Environmental Report Chapter 7 - Radiological Assessment. HPR/GDA/PCER/0007 Revision 002, October 2021.

GNSL, 2021v.

Pre-Construction Safety Report Chapter 22 - Radiological Protection. HPR/GDA/PCSR/0022 Revision 002, October 2021.

GNSL, 2021w.

Pre-Construction Environmental Report Chapter 8 - Conventional Impact Assessment. HPR/GDA/PCER0008 Revision 002, October 2021.

GNSL, 2021x.

Estimation of Radioactive Gaseous and Liquid Discharges and Limits for UK HPR1000. GHX35000002DNFP03GN, Rev F, April 2021.

GNSL, 2021y

Master Document Submission List, HPR-GDA-REPO-0197_Rev001, November 2021.

GNSL, 2021z

UK HPR1000 Long Term Storage of Spent Fuel – Design Criteria. GHX42500032SFSL44GN, Revision 3, May 2021.

GNSL, 2020a.

Optioneering Report for Operational Solid Waste Processing Techniques. GHX0010005DNFF03GN, Revision D, June 2020.

GNSL, 2020b.

Response to LLWR Agreement in Principle. GHX00100099DNFF03GN, Revision B, June 2020.

GNSL, 2020c.

Selection of Waste Containers for Disposal of ILW. GHX00100055DNFF03GN, Revision C, June 2020.

GNSL, 2019a.

Scope for UK HPR1000 GDA Project. HPR-GDA-REPO-0007, Revision 001. July 2019.

GNSL, 2019b.

Technology Optioneering on Spent Fuel Interim Storage. GHX0100057DNFF03GN, Revision B, March 2019.

GNSL, 2019c.

Chemical Emission Inventory for Water Discharge. GHX00530002DOHB02GN Rev C November 2019

IAEA, 2004.

Technical Reports Series No. 421, Management of Waste Containing Tritium and Carbon-14, July 2004.

ICRP, 1991.

1990 Recommendations of the International Commission on Radiological Protection. ICRP Publication 60. Ann. ICRP 21(1–3).

ICRP, 2012.

Compendium of Dose Coefficients based on ICRP Publication 60. ICRP Publication 119. Ann. ICRP 41(Suppl.).

LLWR Ltd, 2020.

Letter Re: Disposability in Principle Assessment for UK HPR1000. GNSL Ref: GHX00100036DNFF03GN, January 2020.

NDA, 2017.

Industry Guidance Interim Storage of Higher Activity Waste Packages - Integrated Approach. Issue 3, January 2017.

NDA, 2014.

Geological Disposal: An Overview of the RWM Disposability Assessment Process. WPS GD No. WPS650/03, April 2014.

NDA, 2012.

ENG01 - Specification and guidance on the content and format of an integrated waste strategy.

ONR, 2021

Step 4 Assessment Report for Fuel and Core of the UK HPR1000. ONR-NR-AR-21-021, 2021

Office for Nuclear Regulation and others, 2021.

The management of higher activity radioactive waste on nuclear licensed sites - Joint guidance to nuclear licensees, Revision 2.1, July 2021.

Office for Nuclear Regulation, the Environment Agency, the Scottish Environment Protection Agency, Natural Resources Wales

Office for Nuclear Regulation and Environment Agency, 2018.

Letter: UK HPR1000 GDA Scope for Spent Fuel Interim Storage (SFIS). Reference 2018/329187, October 2018.

Prohl, G.S., Gomez-Ros, J-M., Jones, S., Taranenko, V., Thørring, H., Vives i Batlle, J. and Woodhead, D. 2003.

Framework for assessment of environmental impact - Fasset - deliverable 3 – Dosimetric models and data for assessing radiation exposures to biota. June 2003.

RWM, 2020.

GOV.UK Geological disposal.

https://www.gov.uk/guidance/geological-disposal

UK parliament, 2020.

The Greenhouse Gas Emissions Trading Scheme Order 2020. SI 2020 No. 1265.

The Greenhouse Gas Emissions Trading Scheme Order 2020 (legislation.gov.uk)

UK parliament, 2018.

The Environmental Permitting (England and Wales) (Amendment) Regulations 2018. SI 2018 No. 110 (as amended).

https://www.legislation.gov.uk/uksi/2018/110/contents/made

UK parliament, 2016.

The Environmental Permitting (England and Wales) Regulations 2016, SI 2016 No. 1154, as amended.

The Environmental Permitting (England and Wales) Regulations 2016 (legislation.gov.uk)

UK parliament, 2015.

The Control of Major Accident Hazards Regulations 2015, SI 2015 No. 483.

The Control of Major Accident Hazards Regulations 2015 (legislation.gov.uk)]

UK parliament, 2009.

The Eels (England and Wales) Regulations 2009. SI 2009 No. 3344 (as amended).

http://www.legislation.gov.uk/uksi/2009/3344/contents/made

UK parliament, 2008.

The Energy Act 2008.

https://www.legislation.gov.uk/ukpga/2008/32/contents

UK parliament, 1995.

The Environment Act 1995.

https://www.legislation.gov.uk/ukpga/1995/25/contents

UK parliament, 1991.

Water Resource Act 1991.

https://www.legislation.gov.uk/ukpga/1991/57/contents

20. List of abbreviations

Abbreviation	Details
AF	Assessment Finding
ALARA	As low as reasonably achievable
AMR	Advanced modular reactors
BAN	Bradwell Action Network
BANNG	Blackwater Against New Nuclear Group
BAT	Best available techniques
BEIS	Department for Business, Energy and Industrial Strategy
BERR	Department for Business, Enterprise and Regulatory Reform
BRB	Bradwell B
CAE	Claims, argument and evidence
CGN	China General Nuclear Power Corporation
COMAH	Control of Major Accident Hazards
CVS	Condenser vacuum system
DAC	Design acceptance confirmation
DCO	Development consent order
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DG	Diesel generator

Abbreviation	Details
EDF	Électricité de France
EDG	Emergency diesel generator
EMIT	Examination, maintenance, inspection and testing
ENDP	Engineering developed principle
EPF	Environmental protection function
EPR16	Environmental Permitting Regulations 2016
ESDG	Emergency security diesel generator
F-gases	Fluorinated gases
GDA	Generic design assessment
GDF	Geological disposal facility
gDSSC	Generic disposal system safety case
GGETSR12	Greenhouse Gas Emissions Trading Scheme Regulations 2012
GNI	General Nuclear International Limited (UK subsidiary of CGN)
GNSL	General Nuclear System Ltd
GWTS	Gaseous waste treatment system
HAW	Higher activity waste
HEPA	High efficiency particulate air (filter)
HLW	High level waste
HVAC	Heating ventilation and air conditioning (system)

Abbreviation	Details
IAEA	International Atomic Energy Agency
ICIA	In-situ core instrument assembly
ICRP	International Commission on Radiological Protection
ILW	Intermediate level waste
iSoDA	Interim statement of design acceptability
IWS	Integrated waste strategy
JPO	Joint Programme Office
LAW	Lower activity waste
LLW	Low level waste
LLWR	Low Level Waste Repository
LoC	Letter of compliance
LWDS(CI)	Conventional Island Liquid Waste Discharge System
LWTS	Liquid waste treatment system
MATTE	Major accident to the environment
MCP	Medium combustion plant
MCZ	Marine conservation zone
MRR	Monitoring and reporting regulation
MSQA	Management for Safety and Quality Assurance
MWe	Megawatt (electricity)

Abbreviation	Details
MWth	Megawatt thermal
NDA	Nuclear Decommissioning Authority
NFCCs	Non-fuel core components
NGO	Non-government organisation
NLWDS	Nuclear Island Liquid Waste Discharge System
NPS EN-6	National Policy Statement Energy-6 (nuclear)
ONR	Office for Nuclear Regulation
OPEX	Operating experience
P&ID	Process and Information Document
PCER	Pre-Construction Environmental Report
PCSR	Pre-Construction Safety Report
PWR	Pressurised water reactor
RCCA	Rod cluster control and assembly
REPs	Radioactive Substances Regulatory Environmental Principles
RGP	Relevant good practice
RI	Regulatory Issue
RO	Regulatory Observation
RP	Requesting Party
RPV	Reactor pressure vessel

Abbreviation	Details
RQ	Regulatory Query
RSMDP	Radioactive substance management developed principle
RSR	Radioactive Substance Regulation
RWM	Radioactive Waste Management Ltd
RWMC	Radioactive Waste Management Case
RVI	Reactor vessel internals
SBO DG	Station black-out diesel generator
SCC	Stress corrosion cracking
SCCAs	Secondary core component assemblies
SEDP	Site evaluation developed principle
SFA	Spent fuel assembly
SFIS	Spent fuel interim store
SG	Steam generator
SGBS	Steam Generator Blowdown System
SMR	Small modular reactor
SNS	Secondary neutron sources
SoDA	Statement of design acceptability
SSC	Structures, systems and components
SSS	Station sewer system

Abbreviation	Details
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
UK HPR1000	UK version of the Hualong pressurised water reactor (HPR1000)
VLLW	Very low level waste
WFCSC	Waste Fluid Collection System for Conventional Island
WONWDS	Waste oil and non-radioactive water drainage system
WRA91	Water Resources Act 1991

Appendix 1: A copy of the SoDA

Environment Agency

Generic Design Assessment of nuclear power plant designs

Statement of Design Acceptability for the UK HPR1000

Requesting Party:

China General Nuclear Power Corporation
Électricité de France S.A.
General Nuclear International Limited

The Environment Agency has undertaken a Generic Design Assessment of the UK HPR1000 nuclear power plant design as submitted by General Nuclear System Limited acting for the requesting party China General Nuclear Power Corporation, Électricité de France S.A. and General Nuclear International Limited

The Generic Design Assessment was carried out during the period January 2017 to January 2022 in accordance with the process set out by the Environment Agency in its guidance document: Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs [1].

The conclusions and outcome of the Environment Agency's assessment is summarised in: **Generic design assessment of the UK HPR1000 design - Decision document** [2]

The Environment Agency is satisfied that the Requesting Party has demonstrated the acceptability for environmental permitting in England of the UK HPR1000 on the generic site, as defined in Schedule 1 to this Statement of Design Acceptability. This statement is provided as advice to the Requesting Party, under section 37 of the Environment Act 1995.

This statement will remain valid for ten years from the date of issue. This is subject to any significant relevant new information which arises during that period which necessitates review or revision of the assessments carried out for this Generic Design Assessment for the UK HPR1000.

Provision of this Statement of Design Acceptability by the Environment Agency does not guarantee that any site-specific applications for environmental permits for the UK HPR1000 will be successful.

Saffron Price-Finnerty Manager, Nuclear Regulation Group (North)	10 January 2022

Authorised on behalf of the Environment Agency

References

1. Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs, Version 3, Environment Agency, October 2016. LIT7998.

   https://www.gov.uk/government/publications/assessment-of-candidate-nuclear-power-plant-designs

2. Generic Design Assessment of the UK HPR1000. Decision Document. Environment Agency, January 2022.

Schedule 1 – Scope of the GDA

This statement of design acceptability refers to the UK HPR1000 as described in the design reference documentation:

Document reference	Title	Version number
NE15BW-X-GL-0000-000047	UK HPR1000 Design Reference Report, 10 September 2021	Rev I
HPR/GDA/PCER-001 to 008	Pre-construction Environmental Report, 29 September 2021	Rev 002
HPR/GDA/PCSR-001 to 033	Pre-construction Safety Report, 29 September 2021	Rev 002
HPR/GDA/REPO/0197	Master Document Submission List, 19 November 2021	Rev 001

Appendix 2: Collation of Assessment Findings

Our Assessment Findings are summarised below, but should be read with the supporting information presented in our assessment reports to provide context (Environment Agency, 2022a to 2022h). We expect future operators to address the findings during the appropriate phase of any new build project.

Assessment Finding 1: The future site operator shall develop arrangements for managing GDA commitments, Assessment Findings, requirements and assumptions relating to environmental protection aspects of the design. (Environment Agency, 2022a).

Assessment Finding 2: If a future site operator has multiple sites, an assessment of best available techniques (BAT) should be produced which covers all of its sites, noting the proximity principle, economies of scale and other efficiencies in disposal of solid and incinerable liquid wastes. The assessment should form part of a future operator's submissions for its second and subsequent environmental permit applications. (Environment Agency, 2022b).

Assessment Finding 3: A future operator shall develop arrangements for managing environment protection measures. This should include specification, procurement, manufacturing, commissioning and operation, including examination, maintenance, inspection and testing requirements. (Environment Agency, 2022c).

Assessment Finding 4: A future operator shall consider the potential high efficiency particulate air (HEPA) filter sealing performance technique improvements being considered for nuclear new builds including Hinkley Point C to ensure application of good practice. (Environment Agency, 2022c).

Assessment Finding 5: A future operator shall have arrangements to periodically review the practicability of techniques for abating carbon-14. **(**Environment Agency, 2022c**).**

Assessment Finding 6: A future operator shall periodically review the possibility to remove secondary neutron sources or to optimise their design at the earliest opportunity. (Environment Agency, 2022c).

Assessment Finding 7: A future operator shall demonstrate that the UK HPR1000 will be operated in a way that represents best available techniques for the selection and change strategy of demineraliser resins and filters for liquid waste management systems. (Environment Agency, 2022c).

Assessment Finding 8: A future operator shall address the BAT relevant post-GDA commitments the Requesting Party identified in the Post-GDA Commitment List, GHX00100084KPGB03GN. (Environment Agency, 2022c).

Assessment Finding 9: A future operator shall assess the impact of its proposed operating fuel cycle on the radioactive waste generation and disposal before implementing any changes. (Environment Agency, 2022c).

Assessment Finding 10: A future operator shall specify procedures to detect failed fuel and act to minimise discharges to the environment. (Environment Agency, 2022c).

Assessment Finding 11: A future operator shall periodically review and continue to optimise water chemistry regimes presented during GDA to reduce waste generation. (Environment Agency, 2022c).

Assessment Finding 12: A future operator shall demonstrate that the dissolved nitrogen level in the primary coolant is minimised. (Environment Agency, 2022c).

Assessment Finding 13: A future operator shall define a procedure to follow in the event of leakage to the secondary circuit that demonstrates the discharge of activity to the environment is minimised. (Environment Agency, 2022c).

Assessment Finding 14: A future operator shall periodically review and continue to optimise the balance between gaseous, liquid and solid phase disposals of carbon-14. (Environment Agency, 2022c).

Assessment Finding 15: A future operator shall assess the chemical form of carbon-14 discharged to the environment and use this to help inform future dose assessments. (Environment Agency, 2022c).

Assessment Finding 16: A future operator shall keep the headroom factors derived during GDA under review. Operational data generated by the UK HPR1000 should be used to periodically revise the headroom factors to ensure that they are the minimum necessary to permit normal operation. (Environment Agency, 2022d).

Assessment Finding 17: A future operator shall ensure that its characterisation programme will identify any hazardous materials and non-hazardous pollutants, to ensure that the inventory for disposal is accurate, for the UK HPR1000. (Environment Agency, 2022e).

Assessment Finding 18: A future operator shall assess whether there are benefits in periodic decontamination of the UK HPR1000 primary circuit and its related systems and auxiliary circuits, during the operational phase, with regard to minimising production of decommissioning wastes and their classification. The future operator should demonstrate that BAT is being applied. (Environment Agency, 2022e).

Assessment Finding 19: A future operator shall ensure that the decommissioning plan is periodically reviewed to demonstrate ensure that BAT is being applied with regard to decommissioning the UK HPR1000. (Environment Agency, 2022e).

Assessment Finding 20: A future operator shall review periodically the options for the treatment and disposal of solid low level waste from the operation and decommissioning of

the UK HPR1000. The future operator shall ensure that the options implemented are BAT and will meet the disposal facilities waste acceptance criteria. (Environment Agency, 2022e).

Assessment Finding 21: A future operator shall periodically update the Radioactive Waste Management Case or equivalent documentation in accordance with the Environment Agency's and ONR's joint guidance, in order to demonstrate that the higher activity waste is being managed across the whole life cycle. (Environment Agency, 2022e).

Assessment Finding 22: A future operator shall develop its characterisation strategy and approach to segregation for solid and non-aqueous wastes further at the detailed design stage, to demonstrate ensure that it can demonstrate that BAT is being applied. (Environment Agency, 2022e).

Assessment Finding 23: A future operator shall ensure that the proposed conditioning and packaging options for the higher activity wastes for the operational and decommissioning waste arisings from the UK HPR1000 are BAT. (Environment Agency, 2022e).

Assessment Finding 24: A future operator shall develop arrangements for identifying and managing non-compliant waste packages, to ensure that only packages that are suitable for disposal would be transferred to a GDF. (Environment Agency, 2022e).

Assessment Finding 25: A future operator shall ensure that it deploys BAT for the conditioning of the spent fuel, prior to transferring the spent fuel assemblies to the spent fuel interim store. (Environment Agency, 2022e).

Assessment Finding 26: A future operator shall ensure that the future design of the spent fuel interim store will deliver the long-term storage requirements for maintaining the integrity of the fuel, to ensure that it will be disposable in the future. (Environment Agency, 2022e).

Assessment Finding 27: A future operator shall ensure that the monitoring and inspection of the spent fuel assemblies and canister within the spent fuel interim store are BAT. (Environment Agency, 2022e).

Assessment Finding 28: A future operator shall ensure that the strategy for managing failed fuel over the lifetime of the UK HPR1000 is BAT to minimise discharges and maintains fuel in an acceptable condition to enable its future disposal. (Environment Agency, 2022e).

Assessment Finding 29: A future site operator shall ensure that it addresses the disposability issues RWM raised within GDA, as part of the site-specific disposability assessment process. (Environment Agency, 2022e).

Assessment Finding 30: A future operator shall engage with the operators of the disposal facilities to ensure that their requirements are complied with for both low activity wastes and higher activity wastes lifetime records. (Environment Agency, 2022e).

Assessment Finding 31: A future operator shall continue to secure international OPEX with regard to the dry storage of spent fuels and ensure that it applies learning from the international OPEX to the storage of the UK HPR1000 fuel arisings. (Environment Agency, 2022e).

Assessment Finding 32: A future operator shall secure and use OPEX, including that available internationally, to ensure that BAT is used to decommission the UK HPR1000, and that the generation of radioactive solid waste is minimised and is capable of being disposed of. (Environment Agency, 2022e).

Assessment Finding 33: A future operator shall demonstrate that, before signing the relevant procurement contracts, the selected sampling and monitoring equipment for determining the discharges are best available techniques, and enable the statutory required levels of detection to be met. (Environment Agency, 2022f).

Assessment Finding 34: A future operator shall demonstrate, before reactor commissioning commences, that the final configuration of the sampling lines and the layout and positioning of the monitoring room are optimised to comply with ISO2889 and the use of best available techniques. (Environment Agency, 2022f).

Assessment Finding 35: A future operator shall demonstrate that the systems and equipment used for monitoring and sentencing solid and non-aqueous liquid waste are best available techniques. (Environment Agency, 2022f).

Assessment Finding 36: A future operator shall address the monitoring post-GDA commitments the Requesting Party identified in the Post-GDA Commitment List, GHX00100084KPGB03GN. (Environment Agency, 2022f).

Assessment Finding 37: A future operator shall engage with the local water supply company early in the site-specific stage. This is to ensure that sufficient quantities of fresh water can be supplied to meet the requirements of the UK HPR1000 or to determine whether an alternative source of fresh water will need to be identified. (Environment Agency, 2022h).

Assessment Finding 38: A future operator shall ensure that the siting of the cooling water intake and outlets are BAT for the UK HPR1000 design at each specific site. (Environment Agency, 2022h).

Assessment Finding 39: A future operator shall review the calculations for emissions of chemicals as part of the site-specific environmental risk assessment. Particular attention should be focused on the application of possible treatment techniques for hydrazine to reduce the amount discharged to the environment and arrangements to minimise any impact. (Environment Agency, 2022h).

Assessment Finding 40: A future operator shall ensure that the storage, treatment and monitoring systems for the 3 non-radioactive effluent streams provide the appropriate level of environmental protection for the receiving environment in terms of quality of effluent

discharged. This would be regulated by a water discharge activity permit. (Environment Agency, 2022h).

Assessment Finding 41: A future operator shall provide in an application for a water discharge activity environmental permit a site-specific environmental impact assessment for discharges to water. The modelling shall use site-specific parameters based on the environmental setting and the specific chemicals selected for use. (Environment Agency, 2022h).

Assessment Finding 42: A future operator shall provide in an application for an environmental permit a BAT assessment of the specific combustion plant selected for use against the relevant BAT guidance at the time of application. (Environment Agency, 2022h).

Assessment Finding 43: A future operator shall provide in an application for a combustion activity environmental permit a site-specific environmental impact assessment for discharges to air. The modelling shall use site-specific parameters based on the environmental setting and the specific combustion plant selected for use. (Environment Agency, 2022h).

Assessment Finding 44: A future operator shall keep the chemical inventories on its site under review so any applicability of COMAH can be identified early and the necessary major accident prevention measures can be installed. (Environment Agency, 2022h).

Assessment Finding 45: A future operator shall keep the fluorinated greenhouse gases proposed for use in the UK HPR1000 under review to ensure they continue to be legally acceptable for use. (Environment Agency, 2022h).

Appendix 3: The Requesting Party's Final GDA submission

PCER01 - Pre-Construction Environmental Report Chapter 1- Introduction. HPR/GDA/PCER/0001 Revision 002, October 2021.

PCER02 - Pre-Construction Environmental Report Chapter 2- Generic Site Description. HPR/GDA/PCER/0002 Revision 002, October 2021.

PCER03 - Pre-Construction Environmental Report Chapter 3 – Demonstration of BAT. HPR/GDA/PCER/0003, Revision 002, October 2021.

PCER04 - Pre-Construction Environmental Report Chapter 4 - Radioactive Waste Management Arrangements. HPR/GDA/PCER/0004, Revision 002, October 2021.

PCER05 - Pre-Construction Environmental Report Chapter 5 - Approach to Sampling and Monitoring. HPR/GDA/PCER/0005, Revision 002, October 2021.

PCER06 - Pre-Construction Environmental Report Chapter 6 – Quantification of Discharges and Limits. HPR/GDA/PCER/0006, Revision 002, October 2021.

PCER07 - Pre-Construction Environmental Report Chapter 7 - Radiological Assessment. HPR/GDA/PCER/0007 Revision 002, October 2021.

PCER08 - Pre-Construction Environmental Report Chapter 8 - Conventional Impact Assessment. HPR/GDA/PCER0008 Revision 002, October 2021.

See also relevant chapters of the Pre-Construction Safety Report.

These documents can be found on the RP website.

Appendix 4: Environment Agency detailed assessment reports

Our assessment reports are listed below:

AR01 - Management systems for the UK HPR1000 design

AR02 - Strategic considerations for radioactive waste management for the UK HPR1000 design

AR03 - Best available techniques for the UK HPR1000 design

AR04 - Gaseous and liquid discharges of radioactive waste for the UK HPR1000 design

AR05 – Solid radioactive waste, spent fuel and disposability for the UK HPR1000 design

AR06 - Sampling and monitoring for the UK HPR1000 design

AR07 - Generic site, doses to the public and dose rates to wildlife for the UK HPR1000 design

AR08 - Other environmental regulations for the UK HPR1000 design

You can find these documents on the GDA: General Nuclear System Limited's UK HPR1000 nuclear power design document collection.

We also commissioned an independent contractor to carry out an independent dose assessment on our behalf.

Independent dose assessment to support the Environment Agency's assessment of General Nuclear System Limited's UK HPR1000

Appendix 5: Consultation questions

Below is a full list of the questions that we asked for responses to, as part of our consultation on the UK HPR1000 design.

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

1. management systems?
2. strategic considerations for radioactive waste management?
3. the process for identifying best available techniques or on the techniques used to minimise production and disposal of radioactive waste?
4. minimising the discharges and impact of gaseous and liquid waste, and our proposed limits and levels?
5. the management and disposal of solid radioactive waste and spent fuel?
6. monitoring discharges and disposals of radioactive waste?
7. the impact of discharges of radioactive waste?
8. radioactive substances permitting?
9. water abstraction?
10. discharges to surface waters and groundwater?
11. the operation of installations?
12. the control of major accident hazards?
13. the measures to prevent and minimise leakage of fluorinated greenhouse gases and ozone-depleting substances?
14. the acceptability of the design?

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

Appendix 6: List of consultation respondents

Response No.	Respondent	Response by	E-consultation Ref
UKHPR1000-001	Joint Nature Conservation Council	Email	Not applicable
UKHPR1000-002	Bradwell on Sea Parish Council	Email	Not applicable
UKHPR1000-003	Water Management Alliance – a member- internal drainage boards	Email	Not applicable
UKHPR1000-004	An individual	the RP comments process	Not applicable
UKHPR1000-005	An individual	the RP comments process	Not applicable
UKHPR1000-006	An individual	Email	Not applicable
UKHPR1000-007	Low level radiation campaign	Email	Not applicable
UKHPR1000-008	Maldon Society	Email	Not applicable
UKHPR1000-009	Nuclear Free Local Authorities	Email	Not applicable
UKHPR1000-010	Chelmsford City Council	Email	Not applicable
UKHPR1000-011	Essex County Council and Maldon District Council – joint response	Email	Not applicable
UKHPR1000-012	An individual	Email	Not applicable
UKHPR1000-013	Low level radiation campaign	Email	Not applicable
UKHPR1000-014	Blackwater Against New Nuclear Group	Email	Not applicable
UKHPR1000-015	Together Against Sizewell C	Email	Not applicable
UKHPR1000-016	An individual	Email	Not applicable
UKHPR1000-017	An individual	Email	Not applicable
UKHPR1000-018	An individual	Email	Not applicable
UKHPR1000-019	An individual	Email	Not applicable
UKHPR1000-020	Leveller Publishing Group	E-consultation	ANON-43QH-ZS4V-Q
UKHPR1000-021	An individual	E-consultation	ANON-43QH-ZS4W-R

Response No.	Respondent	Response by	E-consultation Ref
UKHPR1000-022	An individual	E-consultation	ANON-43QH-ZS4M-E
UKHPR1000-023	An individual	E-consultation	ANON-43QH-ZS4Z-U
UKHPR1000-024	An individual	E-consultation	ANON-43QH-ZS4D-5
UKHPR1000-025	An individual	E-consultation	ANON-43QH-ZS4J-B
UKHPR1000-026	An individual	E-consultation	ANON-43QH-ZS4F-7
UKHPR1000-027	An individual	E-consultation	ANON-43QH-ZS8Y-X
UKHPR1000-028	An individual	E-consultation	ANON-43QH-ZS84-S
UKHPR1000-029	An individual	E-consultation	ANON-43QH-ZS8D-9
UKHPR1000-030	An individual	E-consultation	ANON-43QH-ZS8A-6
UKHPR1000-031	An individual	E-consultation	ANON-43QH-ZSNY-M
UKHPR1000-032	An individual	E-consultation	ANON-43QH-ZSNP-B
UKHPR1000-033	An individual	E-consultation	ANON-43QH-ZSND-Y
UKHPR1000-034	An individual	E-consultation	ANON-43QH-ZSNG-2
UKHPR1000-035	An individual	E-consultation	ANON-43QH-ZSSV-P
UKHPR1000-036	An individual	E-consultation	ANON-43QH-ZSSY-S
UKHPR1000-037	An individual	E-consultation	ANON-43QH-ZSS6-P
UKHPR1000-038	An individual	E-consultation	ANON-43QH-ZSSE-5
UKHPR1000-039	An individual	E-consultation	ANON-43QH-ZSSD-4
UKHPR1000-040	An individual	E-consultation	ANON-43QH-ZSSB-2
UKHPR1000-041	An individual	E-consultation	ANON-43QH-ZSSU-N
UKHPR1000-042	An individual	E-consultation	ANON-43QH-ZSSH-8

Response No.	Respondent	Response by	E-consultation Ref
UKHPR1000-043	West Mersea Town Council	E-consultation	ANON-43QH-ZSSX-R
UKHPR1000-044	Food Standards Agency	E-consultation	ANON-43QH-ZS51-K
UKHPR1000-045	Colchester Borough Council	E-consultation	ANON-43QH-ZS5R-M
UKHPR1000-046	Blackwater Against New Nuclear Group (Duplicate of UKHPR1000-014)	E-consultation	ANON-43QH-ZS5Z-V
UKHPR1000-047	Bradwell B Action Network	E-consultation	ANON-43QH-ZS5C-5
UKHPR1000-048	An individual	E-consultation	ANON-43QH-ZS59-U
UKHPR1000-049	An organisation	E-consultation	ANON-43QH-ZS5D-6
UKHPR1000-050	An individual	E-consultation	ANON-43QH-ZS5Q-K
UKHPR1000-051	An individual	Post	Not applicable
UKHPR1000-052	An individual	Email	Not applicable

Appendix 7: Consultation responses and replies

A7.1 Introduction

In response to our consultation, we received 52 responses from individuals and organisations, (UKHPR1000-001 to UKHPR1000-052), some of which were duplicates or blank. Full responses and the reference we have given them can be found in our Responses to GDA consultation for the UK HPR1000, published July 2021.

This appendix addresses each response consistent with our regulatory responsibilities and our detailed assessment conclusions. We address each response in one or more of 3 sections to this appendix as follows:

- responses that fall wholly or partially within our regulatory remit and where there is some consideration that is within the scope of GDA (section A7.2)
- responses that fall outside of the scope of our GDA remit (section A7.3) - here we briefly explain why the response is out of scope
- responses that fall wholly or partially within the remit of another organisation and, therefore, are outside our responsibility as an environmental regulator (section A7.4) - here we identify who we have passed the response on to for consideration

Points raised within some responses are addressed within more than one section of this appendix, for example, where some aspects of a response might be directly relevant to our remit and within the scope of GDA, whereas others fall outside of the scope of GDA or our regulatory remit. Where relevant, we provide references to where responses are also noted or assessed further, such as in our assessment reports. Table A7.1 below indicates in which section of this appendix aspects of each consultation response is addressed.

Table A7-1 Sections within this appendix where points raised in each consultation response are addressed

Response reference	Within regulatory remit and GDA scope (Appendix A7.2)	Outside scope of our GDA remit (Appendix A7.3)	Outside of our regulatory responsibilities (Appendix A7.4)
UKHPR1000-001	Confirming no comments	Confirming no comments	Confirming no comments
UKHPR1000-002	✓		
UKHPR1000-003		✓	
UKHPR1000-004		✓	
UKHPR1000-005		✓	
UKHPR1000-006		✓	✓
UKHPR1000-007	✓	✓	✓

Response reference	Within regulatory remit and GDA scope (Appendix A7.2)	Outside scope of our GDA remit (Appendix A7.3)	Outside of our regulatory responsibilities (Appendix A7.4)
UKHPR1000-008		✓	✓
UKHPR1000-009	✓		✓
UKHPR1000-010	✓		✓
UKHPR1000-011	✓	✓	✓
UKHPR1000-012			✓
UKHPR1000-013	✓	✓	✓
UKHPR1000-014	✓	✓	✓
UKHPR1000-015	✓	✓	✓
UKHPR1000-016		✓	✓
UKHPR1000-017	✓	✓	
UKHPR1000-018	✓	✓	✓
UKHPR1000-019	✓	✓	
UKHPR1000-020			✓
UKHPR1000-021	✓		✓
UKHPR1000-022	This response had no content	This response had no content	This response had no content
UKHPR1000-023	This response had no content	This response had no content	This response had no content
UKHPR1000-024			✓
UKHPR1000-025			✓
UKHPR1000-026	✓		✓
UKHPR1000-027	✓		✓
UKHPR1000-028			✓
UKHPR1000-029		✓	
UKHPR1000-030			✓
UKHPR1000-031	✓		✓
UKHPR1000-032	✓		✓
UKHPR1000-033	✓		
UKHPR1000-034	✓	✓	✓
UKHPR1000-035	✓		
UKHPR1000-036		✓	✓
UKHPR1000-037	✓		✓
UKHPR1000-038		✓	✓
UKHPR1000-039	✓	✓	
UKHPR1000-040	✓		✓
UKHPR1000-041	✓	✓	✓
UKHPR1000-042			✓

Response reference	Within regulatory remit and GDA scope (Appendix A7.2)	Outside scope of our GDA remit (Appendix A7.3)	Outside of our regulatory responsibilities (Appendix A7.4)
UKHPR1000-043	✓	✓	✓
UKHPR1000-044	✓		
UKHPR1000-045	✓	✓	✓
UKHPR1000-046	Duplicate of UKHPR1000-014	Duplicate of UKHPR1000-014	Duplicate of UKHPR1000-014
UKHPR1000-047	✓	✓	✓
UKHPR1000-048	✓	✓	✓
UKHPR1000-049		✓	
UKHPR1000-050	✓	✓	✓
UKHPR1000-051		✓	✓
UKHPR1000-052		✓	✓

A7.2 Responses within our regulatory remit and within the scope of GDA

Those responses that fall within both our regulatory remit and within the scope of this GDA are covered in the section below. Subsections A7.2.1 to A7.2.3 cover our response to overarching themes relating to the GDA process, the GDA scope and the consultation. Specific technical points are covered in detail in the related assessment reports but are also summarised in section A7.2.4.

A7.2.1 GDA process

Two respondents have raised points relating to the GDA process (UKHPR1000-011 and UKHPR1000-048).

Further information on the GDA process can be found in section 2.4 of this report and in our Process and Information Document (Environment Agency, 2016).

One respondent (UKHPR1000-011) noted that at consultation we had raised 6 potential GDA Issues. While the respondent welcomed the RP's commitment to resolving the Issues by the end of the GDA process, they made a general enquiry about the publication of any resolution plans. They requested that that all resolution plans are published so that stakeholders can see how potential GDA Issues will be addressed, prior to any statement of design acceptability (SoDA) being issued.

Our GDA process is outlined in our Process and Information Document (Environment Agency, 2016). If the potential GDA Issues were not resolved before the end of GDA, our decision would be to award an iSoDA. As part of that decision, we would publish what would be required to close out each Issue and any resultant resolution plan. However, in

this case, all the potential GDA Issues raised during consultation have been now closed out to our satisfaction before the completion of the GDA, therefore there are no additional resolution plans to be published. Details of the closure of the 6 potential GDA Issues previously identified can be found in Appendix 12.

Another respondent (UKHPR1000-048) questioned the logic of issuing an 'iSoDA ' when GDA Issues remain to be resolved.

There are no outstanding GDA Issues and we have explained how each potential GDA Issue previously identified has been resolved in Appendix 12. Issuing an iSoDA would reflect that we had completed our planned assessments, but that there are still issues to be resolved and that the RP has provided us with proposed resolution plans for these issues which we consider to be credible. GDA is the starting point of a long regulatory process, it is not a pass or fail test, it is designed to allow design development to meet UK regulatory needs. GDA aims to highlight potential concerns early in the regulatory process to allow them to be addressed before the design is finalised for construction.

A7.2.2 GDA scope

Eight respondents have raised points relating to the scope of GDA, UKHPR1000-011, UKHPR1000-014, UKHPR1000-018, UKHPR1000-019, UKHPR1000-034, UKHPR1000-043, UKHPR1000-045 and UKHPR1000-050.

Further information on the scope of GDA can be found in section 2.4.2 (for the overall GDA scope) and section 2.5.2 (for the UK HPR1000 specific scope).

Limited scope

Three respondents (UKHPR1000-014, UKHPR1000-015 and UKHPR1000-045) noted that the scope of GDA is very limited, with a particular concern that this made it hard for the public to engage with the GDA consultation. It was also noted that many aspects of concern were outside the control of the Environment Agency, which restricted the topics that could be raised during the consultation.

Nuclear new build projects are complex and take a significant amount of time to implement during which the proposed operator must apply for and secure many permissions from a number of regulators and other bodies. During this time, information available to us increases as decisions are made and the detail of any proposal is clarified. However, we must start somewhere and the starting point is the generic design assessment.

In GDA we look only at those aspects of the reactor design that are expected to be much the same irrespective of where the reactor is deployed. We focus on control and containment of radioactivity, radioactive waste minimisation and disposability, as these characteristics are closely linked to the engineering design. Therefore, when site-specific permit applications are received we can be confident that the engineering should be appropriate and we can focus on the site-specific impacts and how they can be minimised.

Many aspects of environmental interest cannot be assessed until site-specific characteristics are known and are therefore excluded from GDA. However, as a project develops and site-specific permit applications are received, there would be multiple opportunities for future public engagement. For other regulatory aspects, such as planning, public engagement processes focused on those regulatory processes and issues will be held.

See also section A7.3.3 ongoing regulation and section A7.4 responses outside our regulatory responsibilities.

Too technical

Six respondents (UKHPR1000-014, UKHPR1000-019, UKHPR1000-034, UKHPR1000-043, UKHPR1000-045 and UKHPR1000-050) noted that the documentation relating to the consultation was very technical.

We accept that some of the documentation we published was technical. However, nuclear new build is a complex subject. For our consultation, we aimed to provide documentation at 3 different levels of technical detail to cover a range of public needs:

- Our assessment reports contained a high level of technical detail to allow those with a high level of knowledge to make a fully informed response.
- Our consultation document contained a mid-level of detail, suitable to inform any reasonably informed member of the public of our preliminary conclusions and how were reached them.
- Our summary document contained no technical detail beyond what the consultation was about and the various ways to respond to it.

We also held many events to allow the public to ask questions on the documentation. We have followed the same 3 tier approach with our decision documents.

Final GDA design

One respondent noted that it is not clear what aspects of the design were fixed at GDA and what scope there was for change to the design at the site-specific stage (UKHPR1000-011).

At the end of GDA we can choose to award an iSoDA or a SoDA or not to issue either. This is awarded against a set of documents that define the end point of the GDA design. In this case, these are a design reference report and a master document submission list, which is a list of the latest revisions of all supporting documentation (GNSL. 2021y).

As we move to a site-specific application we would not expect to reassess design documents that had been assessed as part of GDA unless there was significant change or new information. However, there is scope for an operator to change any aspects of the design and revise the supporting information should the site characteristics make it necessary or by operator choice. Where design information is changed, it would be subjected to additional regulatory scrutiny.

Generic design variance from BRB DCO consultation

Two respondents (UKHPR1000-011 and UKHPR1000-018) noted that the cooling system in the GDA scope was different from that of the recent Bradwell B (BRB) Development Consent Order (DCO) stage 1 consultation. For GDA, the Requesting Party declared a direct cooling system, where seawater is taken in, used to cool the turbine and discharged. For the DCO consultation, the cooling system was based on hybrid cooling towers. There were concerns over how this difference would be managed and whether this impacts on the future validity of any SoDA (if awarded). It was also clear from discussions during consultation events that this has caused some confusion among the public.

We do not assess the impact of cooling water during GDA. Assessment of cooling water impact is highly site specific and requires complex modelling as part of the determination of a site-specific permit application. As cooling will be examined in the site-specific stage and is not assessed at GDA, it does not impact on the validity of a SoDA if awarded.

Many other aspects cannot be assessed at GDA due to the site-specific information required to carry out a full assessment, see also section A7.3.2 Out of scope – BRB.

A7.2 3 Consultation process

Seven respondents have raised points relating to the GDA consultation process, UKHPR1000-002, UKHPR1000-013, UKHPR1000-014, UKHPR1000-015, UKHPR1000-017, UKHPR1000-043 and UKHPR1000-045:

Inclusivity and effectiveness

Two respondents (UKHPR1000-002 and UKHPR1000-017) raised a concern that the consultation events were online and may have excluded those with no or limited internet access or those who were hard of hearing

The Environment Agency uses a comprehensive range of approaches and tools to consult and engage with stakeholders, including meetings online and in person and in the community. We consider that our consultation was inclusive to all. We used all communication channels available to us apart from face-to-face meetings, which we were unable to do under the Covid-19 restrictions at the time. We promoted our consultation widely, via multiple channels, some digital, some print including local media publications, posters in the community, and via local interested stakeholders and community leaders. The RP also advertised the consultation through the UK HPR1000 website, a community newsletter sent to all households and social media. We increased the number of online events (using Zoom) to ensure those who had questions had an opportunity to ask them. We offered telephone appointments for anyone who was not able to attend online meetings, who wanted to ask us specific questions. Consultation responses could be made using an online consultation tool (Citizen Space), by email, by telephone or by letter through the postal service.

We have considered comments about the hard of hearing. If anyone attending our online consultation events informed us that they were unable to follow the audio, we would have activated the closed captioning system – an instantaneous subtitle facility embedded in the meeting software. For online events going forward, we will highlight accessibility options in the meeting papers, before the meeting. Our future engagement is likely to be a mix of online and face-to-face meetings, Covid-19 restrictions permitting.

One respondent (UKHPR1000-043) raised a concern that the consultation clashed with Easter, a major Christian festival.

When we plan consultations, we check that there are no clashes with major holidays, religious festivals, parliamentary elections or local elections. However, it is rarely possible to find a 12-week period with no events. This consultation ran for 12 weeks (84 days) from Monday 11 January to Friday 4 April 2021. In this instance, only 3 of the scheduled 84 days fell within Easter. Additionally, where we were contacted by people wishing to respond but were unable to meet the closure date, we have accepted late responses to ensure no respondent was at a disadvantage as a result of their religious beliefs.

One respondent (UKHPR1000-015) suggested that the consultation was not effective and that the use of questions in a consultation was not proper engagement.

Using a list of questions in the consultation response form helps to guide respondents to the topic areas in the scope of this GDA consultation. We also included a final open question to allow respondents to include any additional relevant information. Many respondents (UKHPR1000-015 included) opted not to use the response form or questions and submit a freeform response via email. These were all accepted into the consultation responses. Therefore, including questions on the response form is not considered to be restrictive. In addition, engagement events were held to allow the public to understand the GDA scope and raise questions on a wide range of topics.

One respondent (UKHPR1000-043) raised a concern about the lack of involvement of other experts in the nuclear field from outside the Environment Agency.

Our consultation was open to all and was promoted widely to the nuclear industry, nuclear academics, trade and professional societies and groups. Technical leads from the Office for Nuclear Regulation also attended our events to answer questions.

We received a response from the Food Standards Agency who noted that they had carried out their own radiological impact assessment. Their results were in broad agreement with those the RP provided and our own independent dose assessment.

Specific information on how the consultation was undertaken can be found in section 2.5.3 of this report.

Short notice for consultation events

One respondent (UKHPR1000-045) noted that the published consultation plan did not include specific dates and times for the consultation events. Therefore, they felt that insufficient notice was available to event attendees.

A high-level consultation plan was published ahead of the consultation starting, online on 21 December, while the dates of events were still being finalised. When the dates for the online events were agreed, they were advertised widely during January and February on websites, social media, local posters in the community, through e-bulletins and the Citizen Space consultation tool at least 3 weeks before they started. Details of all the events are in section 2.5.3. Online events were offered at times which were accessible to the most people – early evening after work.

Consultation during a pandemic

The 2 respondents (UKHPR1000-002 and UKHPR1000-017) also questioned whether the consultation could be delayed to allow face-to-face interactions.

We carefully considered the timing of the consultation and it was held as late as possible in the GDA programme consistent with our target completion date. However, due to the difficulties of planning public events during Covid-19 restrictions, we did not want to delay the GDA indefinitely. We note that the GDA is only the start of a long regulatory process associated with nuclear new build projects, with many opportunities for further stakeholder engagement and formal consultation.

Specific meeting request

One respondent (UKHPR1000-002) requested a specific meeting for their organisation as part of their response. We were able to accommodate this request.

Unanswered questions during events

Two respondents (UKHPR1000-013 and UKHPR1000-014) noted that there were questions asked at an event (24 February 2021) that remained unanswered, which they considered to be a failure of dialogue.

We received many questions via the online chat function during the consultation event and ran out of time to respond during the meeting. However, we subsequently provided written responses, which were published on 26 March 2021, before the closure of the consultation.

These were published on Citizen Space:

Publication of responses

One respondent (UKHPR1000-014) noted that people have a right to know what the Environment Agency responses to the consultation are.

The Environment Agency always aims to consult and make decisions in an open and transparent manner. We have published each response we received in full, so all can see

the consultation responses that we received. The compilation of responses was published on GOV.UK, alongside the consultation documents. Our responses to the points raised are set out in this document.

Supplementary submissions

One respondent (UKHPR1000-013) asked if they would be able to make additional comments once their unanswered questions were responded to, and after the Environment Agency had responded.

We wrote to the respondent to advise them that we had already responded to the unanswered questions and published the document on Citizen Space on 25 March. We also wrote that we would be happy to accept a further comment by 31 May 2021. No additional response has been received.

Our approach to consultation is in line with the government's consultation principles.

You can also read about when and how we consult on environmental permits.

A7.2.4 Technical points within GDA scope

In addition to the three themes in-scope above (A7.2.1 to A7.2.3) many respondents raised specific technical points related to our preliminary assessment reports. These points are addressed in the topic specific assessment reports in dedicated sections relating to public comments. However, these are also reproduced in full below for completeness.

Management systems

Response reference UKHPR1000-011. The responder requested that all resolution plans are published so that stakeholders can see how Potential GDA Issues will be addressed, prior to any statement of design acceptability (SoDA) being issued.

Our response: All resolution plans for ROs have been published on the regulators GDA website. Additionally, the full set of GDA Assessment Reports will describe how any potential GDA Issues have been closed out (for example, reference to the close-out of the potential GDA Issue on OPEX described in section 2.5 of our MSQA assessment report AR01 (Environment Agency 2022a).

Response reference UKHPR1000-018.The responder questioned the use of the term "appear to be adequate" in relation to our assessment of the management arrangements.

Our response: Our assessment is carried out against the standards and guidance referred to in section 2.1 of our MSQA assessment report AR01 (Environment Agency 2022a), with the aim of determining whether the RP's MSQA arrangements meet those specifications, and so would enable us to proceed with issuing a statement of design acceptability (SoDA). The outcome from the GDA process is therefore a decision as to whether the arrangements are or are not adequate in this respect. Beyond this, no other quality

judgement is made. Regarding using the term "appear to", our assessment process is of necessity a sampling process. We do not examine every element of the RP's arrangements in full detail, and therefore the outcome of the process must be qualified to reflect that we have used a sampling approach to form a broad judgement on the adequacy of the full arrangements. If the arrangements were not acceptable we would say so, take appropriate action and would reflect this in the decisions we make.

Response reference UKHPR1000-032. The responder commented: "the document does not make it clear how management systems will progress over [the timescales for construction, operation, waste storage and decommissioning]", and requested that "It should be made clear how permitting may change over the lifetime of the site that is over several 100 years."

Our response: Our assessment is of the RP's management systems that are used to produce the UK HPR1000 generic design only. The assessment scope does not extend beyond the GDA process, to the construction, operation and decommissioning of the facility. While we do look to see at the generic design development stage that design development considers the functional requirements that these phases of the future facility will need to address, post-GDA management and quality arrangements are for a future operator to develop and demonstrate. Regulatory scrutiny of these phases would be carried out as part of a future operator's application for relevant permits, as part of ongoing compliance inspection and assessment against relevant conditions within those permits, and ultimately at site closure as part of the final permit surrender process.

Response reference UKHPR1000-043. The responder commented: "It is unclear if the organisational capacity and capability is considered ‘adequate’ after investigation by the Environment Agency/ONR or just a report from the RP. On the design management aspect, this is an assurance given by the RP and, as yet, unverified. This point is too substantial to assume it would be completed during the remainder of the GDA process. The transfer information to future licensee arrangements are, again, assumed that they will be completed, ‘adequate progress’ is vague."

Our response: Organisational capacity and capability has been assessed as part of our inspection of GNSL, CGN and EDF at each stage of the GDA process. To do this, we reviewed the RP's plans and procedures, and sampled a range of management system documents and records covering staff numbers, skills, training, and the use of supply chain resources (contractors). It is on this basis that we have determined organisational capacity and capability to be adequate.

Since the issues relating to design management were identified, we have issued RO-UK HPR1000-0024, to which the RP has now responded in full. We have also further inspected CGN's arrangements, including sampling of design management records, to verify that the shortcomings that were identified in step 3 of GDA have been addressed satisfactorily. We are satisfied that this is the case, and RO-UKHPR1000-0024 has now been closed.

The RP developed fully and put in place arrangements for transferring information to a future licensee during the detailed assessment stage of GDA. These arrangements centre on producing suitable and sufficient GDA documentation, including demonstrating that the design represents BAT, identifying GDA design changes compared to the baseline design, and identifying commitments that fall on a future licensee relating to site-specific design development and site-specific operational requirements and assumptions. We are satisfied that these arrangements are adequate to ensure that the documented GDA output is suitable for a future licensee to use.

Response reference UKHPR1000-047. The responder commented: "Without seen [sic] examples of the evidence collected or the number of documents and references to the same, it is somewhat difficult to ascertain exactly what you looked at and comment on it. That said, from the comments you do provide, a robust management system and understanding of what that looks like does not seem to be present. Particularly concerning is the design change management process, corrective actions (i.e. on assessment findings), closeouts etc, there is no mention of responsibilities in terms of whether the system is robust in notifying responsible persons of action needed to be taken, on what and when, or any system for notifying of and escalating when actions are overdue. One would expect, on a project of this scale and cost to have some form of a robust electronic system for capturing the above and sending a notification, escalating when overdue, and providing both a top-level and detailed overview of the status of the overall management system and its various elements, however, there is no mention of such. There is also a lack of comment in respect to overall responsibilities, how these are documented and enforced.

As a qualified lead auditor for both ISO9001 and ISO14001, I found the consultation documentation less than helpful in providing any evidence of robust systems or indeed any confidence that such is either in place or being worked upon. I am left feeling rather concerned that the management system is made up of add hock [sic] arrangements, is poorly thought out, is not clearly defined and fails to meet the standards one would expect for such a high-risk project.

I found the statement that the management systems are broadly equivalent to (ISO14000 and 14001 standards) rather ambiguous in light of the importance of excellent management systems that such a high-risk project should necessitate. Surely one would expect the management system to at least meet the exact requirements of these standards and anything less for such a potentially catastrophic [sic] has to be unacceptable within the UK framework. Of particular note is the lack of information in respect to management control (of which there seems to be very little on the evidence provided) and the effectiveness of the PDCA cycle, which is not specifically mentioned at all."

Our response: The findings of our assessment of the RP's management systems and quality arrangements are reported in summary form in our Assessment Report. This topic area has been subject to ongoing assessment and inspection throughout the UK HPR1000 GDA process by a specific Environment Agency MSQA topic lead, working jointly with MSQA specialist leads within ONR. Arrangements have been assessed and

inspected in detail at each step of the GDA process, within GNSL and its service providers (CGN, and EDF). Our overall finding is that the RP's management system and quality arrangements are adequate for the purpose of GDA and are consistent with applicable guidance and standards, including IAEA GSR Part 2, current Environment Agency and ONR guidance on management systems, and relevant environmental and quality standards ISO9001 and ISO14001. This includes our judgement that the arrangements are systematic and integrated, and are supported by effective governance arrangements and assurance activities (including independent audit). Regarding design management, we did identify some shortcomings in these arrangements earlier in the detailed assessment stage. As a result, and as described earlier in this report, we issued RO-UKHPR1000-0024, to which the RP has now responded in full. We have further inspected CGN's arrangements, including sampling of design management records, to verify that the shortcomings that we identified have been addressed satisfactorily. We are satisfied that this is the case, and RO-UKHPR1000-0024 has now been closed. On arrangements for corrective actions, the RP uses an electronic system for capturing, sentencing for action and tracking completion of corrective actions, and we have sampled the effectiveness of this system as part of our inspections. We are satisfied that the RP's arrangements on corrective action are adequate.

Strategic considerations of radioactive waste management

We received a comment (UKHPR1000-011) regarding the long-term management of higher activity wastes and the future availability of a geological disposal facility (GDF). The IWS identifies the wastes that would require disposal in a GDF and explains that they would be stored on-site until a GDF is available. On-site, interim storage is regulated by ONR. Provision of a GDF is a matter of government policy as described in its document ‘Implementing Geological Disposal’ (BEIS, 2018). The document explains how geological disposal, together with safe and secure interim storage, is considered to be the best approach for the long-term management of higher activity radioactive waste. The IWS the RP presented for the UK HPR1000 GDA is in accordance with the government approach and, as such, meets our expectations. Exploring alternatives to a GDF if government policies change or timescales are delayed is outside the scope of a GDA, which applies the relevant government policies in place at the time of assessment (for further information on government policy and GDF, see section A7.4.4).

We received a comment (UKHPR1000-018) regarding the on-site storage of spent fuel and other radioactive wastes beyond the end of the decommissioning period. Firstly, it is important to note that ONR is the lead authority for the regulation of on-site storage of spent fuel and radioactive wastes. Our involvement in on-site storage relates to protecting the public and ensuring wastes can be disposed of correctly when a facility is available. In terms of our regulation of decommissioning, we define ‘decommissioning’ in our guidance document ‘The decommissioning of nuclear facilities’ (Environment Agency, 2013) as ‘the administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility’. A site providing long-term storage of radioactive waste (like Bradwell A cited as an example in the comment) is still regulated by the Environment Agency (that is, it still holds an environmental permit) and cannot be released from

regulation until it has been decommissioned and cleaned-up to the relevant standards. (Environment Agency, 2018b).

We received a comment (UKHPR1000-031) stating that discharges should be solidified wherever possible. The IWS highlights the importance of the waste hierarchy and the principle of ‘concentrate and contain’ in any decision making. This ensures that wastes requiring disposal are minimised as far as possible and are in the least mobile waste form. Nuclear power plants are required to apply best available techniques (BAT) to their activities. BAT applies to the disposal of solid, liquid and gaseous wastes and forms part of our assessment at GDA. The disposal options presented in the IWS (GNSL, 2021a) at GDA can be considered BAT at the time of assessment. However, what constitutes BAT will change over time, and any future operator will be required to apply whatever techniques represent BAT at that time.

We received a comment (UKHPR1000-047) relating to our assessment finding, which requires a future operator with multiple sites to ensure it is applying the proximity principle and economies of scale to its waste disposals. This assessment finding is intended for a future operator of the UK HPR1000 that develops more than one nuclear power station at different locations. The comment highlights the consortium approach which is common in the nuclear industry. This assessment finding applies equally to consortiums and individual companies. Efficiencies in waste disposal are a BAT requirement that applies to all nuclear operators all of the time and, as such, forms part of how we regulate the industry as a whole.

Best available techniques

We received responses (UK HPR1000-018 and UK HPR1000-027) concerning our interest in the RP’s choice of HEPA filter. The choice of HEPA filtration is important to ensure the concentration of particulate matter within the gaseous radioactive waste stream is minimised during normal and accident conditions. We are content that the revised option selection report now demonstrates clearly that the RP has fully considered environmental factors during its HEPA option selection process. Further information on this can be found in our best available techniques assessment report, AR03 (Environment Agency 2022c), Appendix 3 for Argument 2c.

We received a response (UK HPR1000-033) concerning the layout and the treatment technologies selected for the LRWMS. These technologies for the LRWMS have been assessed and the choices have been selected following the optioneering process mentioned in our best available techniques assessment report AR03 (Environment Agency 2022c), section 2.11. An Assessment Finding has been raised in AR03 section 2.8 for a future operator to demonstrate that the UK HPR1000 will be operated in a way that represents BAT for the selection and change strategy of demineraliser resins for liquid waste management systems. The process drain stream uses filters and demineralisers to remove suspended and dissolved radioactivity. The diagram in AR03 section 2.8 is a simplified version of the the RP’s process diagrams. The floor drains contain suspended solids and therefore the stream uses filters and the dissolved radioactivity is expected to be low. The floor drains stream can be routed via the evaporator to concentrate and

contain radioactivity. The treatment technologies are established technologies and are still effective. Continuous improvements in efficiency are being made to commercially available filters and ion exchange media, so the media and the technologies are considered to be BAT.

We received a response (UK HPR1000-035) concerning SG tube material selection, which is linked to public comments (ANON-1XYX-8WSA-W and ANON-1XYX-8WSD-Z) received by the RP, as mentioned in AR03 section 4.1. The SG tube material selection has been assessed as detailed in AR03 Appendix 3 for Argument 1f. SG tubes are the most significant source of corrosion products as they have the largest surface area in contact with the primary coolant. Alloy 690TT is used in PWRs worldwide and was selected for the UK HPR1000 SG tubes following the material selection methodology assessed against relevant good practice (RGP) and OPEX. Nickel-based alloys are used because of their corrosion resistance, high temperature strength and thermal expansion properties. Alloy 690TT has been developed and used without reported failure during operation following the observation of stress corrosion cracking (SCC) on earlier stainless steel and alloy SG tube materials. Other SG tube materials include titanium stabilised austenitic stainless steels are not widely used in worldwide PWRs. Waste implications are only one factor of many that need to be considered, and we are content that the process of materials selection is appropriate and has duly considered radioactive waste minimisation. The SG tube material selection is predominantly linked to safety and structural integrity, which ONR has assessed. (https://www.onr.org.uk/new-reactors/uk-hpr1000/reports.htm).

We received a response (UK HPR1000-035) concerning the consideration of cost during the demonstration of BAT. The Environment Act 1995 (UK Parliament, 1995) requires us to take cost into account when exercising our powers, for example, granting a permit. Cost is also a component of ‘reasonable’ in consideration of ALARA. So, we would expect an operator to use cost as one of the criteria within a BAT (optimisation) assessment. The RP has considered cost in the optioneering process, where it is a significant factor, notably in considering HEPA filter choice. The reduction in dose impact between the 2 options was low, but the cost of implementing one option was high (AR03 Appendix 3, Argument 2c) where the cost of building redesign to accommodate cylindrical filters was considered. The RP has also demonstrated that H-3 and C-14 abatement is grossly disproportionate as discussed in AR03, section 2.7.

Discharges and limits

We received comment UKHPR1000-007 on the discharge of alpha particles and comment UKHPR1000-014, which was a more general point about the issue of detectability of alpha activity.

During one of our consultation events, the question of alpha activity in discharges was raised. At the event, we responded to say that discharges of alpha activity from PWRs were so low that they could not be detected. The question was followed up with the event attendee referring to published data on particulates from PWRs published in the UNSCEAR 2000 Annex C as evidence that such activity was discharged to air. We ran out of time to respond to this verbally in the meeting, but provided a written response, which

was published on our consultation website while the consultation was still open (26 March 2021), as follows:

Table 34 documents particulates released from reactors in airborne effluents in GBq, but no indication is given of detailed radionuclide composition or particle size distribution.

Paragraph 141 in the supporting document notes that the particulate composition has been looked at for each reactor type, of all the nuclides noted in the text, none are alpha emitters (see below for UNSCEAR text):

‘The radionuclide composition of releases has been examined for the various reactor types. In general, the releases of noble gases from PWRs are dominated by 133Xe, with a half-life of 5.3 days, but short-lived radionuclides such as 135Xe (half-life = 9.2 h) are also present. For the BWRs the composition of the noble gas releases is more varied, with most krypton and xenon radionuclides included. The releases of particulates from BWRs are also variable and difficult to generalize from the limited data available. The radionuclides 88Rb (half-life = 17.8 min), 89Rb (half-life = 15.2 min), 138Cs (half-life = 33.4 min), and 139Ba (half-life = 83.1 min) were prominent in the large releases mentioned above from the Ringhals 1 reactor. The radionuclide compositions of liquid releases from PWRs seem to vary from reactor to reactor; the cobalt isotopes (58Co, 60Co) as well as the caesium isotopes (134Cs, 137Cs) are usually present. In some cases, large relative proportions of 110mAg and 124Sb are reported. It may be that some differences are accentuated by the various measuring and reporting practices at reactor stations.’

Based on the above, we believe it would be incorrect to assume that the PWR particulate data in UNSCEAR 2000 - Annex C Table 34 indicates alpha discharges or can be considered as a proxy for alpha discharges.

We have assessed the theoretically calculated activity of the primary circuit cooling water calculations to check the relative abundance of the activity concentrations of radionuclides associated with particulates (corrosion products and alpha emitting actinides) in light of this comment. We again note that all the nuclides referred to in UNSCEAR 2000 Annex C paragraph 141 are corrosion products, which are beta/gamma emitting nuclides and not alpha emitting nuclides. Our assessment of the UK HPR1000 source term analysis indicated that alpha activity concentrations are approximately one millionth of the activity concentrations associated with the corrosion products. This supports our written response that alpha discharges are so low that they are unlikely to be detectable and are not a significant radionuclide in the UK HPR1000 discharges.

We received comment UKHPR1000-009 regarding the comparison of discharges with other power stations. The RP made this comparison and our assessment is covered in section 3.4.5 ‘Comparison of UK HPR1000 discharges with similar reactors worldwide’ of the discharges and limits assessment report (Environment Agency 2022d). The key point to highlight here is that all the discharge data used for the comparison in this report has been normalised to 1,000 MWe which enables as meaningful a comparison as possible.

We received comment UKHPR1000-009 regarding the comparison of UKHPR1000 estimated discharges with those of previous PWR GDAs. The comment raised concern that the estimated discharges are not lower than those estimated for other PWR designs that have been previously subjected to GDA. This point was raised by the Environment Agency during our assessment and the RP has provided sufficient explanation for the reasons behind the differences shown in the graphs comparing the 3 designs assessed under GDA. These reasons are outlined in section 3.4.5 of the discharges and limits assessment report (Environment Agency 2022d) 'Comparison of UK HPR1000 discharges with other similar reactors around the world' under the sub-heading 'Comparison with previous PWR GDAs'.

We received a comment UKHPR1000-026 regarding the impact of accidents on discharges. We assess gaseous and liquid discharges from 'normal operations' only. ONR assesses the radiological consequences of accidents and regulates arrangements for the control and mitigation of radiological consequences following a significant release of radioactivity. This is explained, along with the full definition of normal operation in section 3.3 of the discharge and limits assessment report (Environment Agency 2022d) (Assessment limitations and scope).

We received comment UKHPR1000-043, which expressed a view that the use of the becquerel, rather than a more understandable term, is unsatisfactory. The becquerel is the internationally accepted unit of radioactivity and equals one radioactive decay (or nuclear disintegration) per second. Therefore, we cannot carry out any calculations to determine proposed levels of radioactivity released to the environment without using the internationally accepted unit for radioactivity.

We received 2 comments (UKHPR1000-045 and UKHPR1000-047) raising concern about the use of discharge estimates for our decision-making during GDA. It is important to note that during GDA our expectation, as defined in our P&ID (Environment Agency, 2016), is for the RP to estimate discharges and propose limits. The approach the RP took for this GDA was to use operating experience (OPEX) from similar operational plants within the China General Nuclear (CGN) fleet. The source of OPEX used for GDA has been covered in some detail throughout the RP's submission (see the PCER document (GNSL, 2021b)) and we consider this to be a reasonable basis for calculating estimates for GDA. We would expect to see the OPEX refined and improved over time as more data become available. We would use the latest information available when making decisions about limits when considering a site-specific application.

Comment UKHPR1000-047 also raised a question regarding the number of reactors the GDA covered. Our GDA relates to a single reactor and this is stated in section 3.3 of the discharges and limits assessment report (Assessment limitations and scope) (Environment Agency, 2022d).

We received comment UKHPR1000-050, which also raised concerns over the acceptability of discharge estimates and proposed limits and the impact from unexpected accidents. The discharge estimates the RP presented are part of a wider GDA submission where applying BAT to minimise the amount of radioactive waste that needs to be

discharged has to be justified (see our assessment report ‘Best available techniques’ (Environment Agency, 2022c)). The discharge estimates are compared with comparable plant worldwide in this report and the proposed limits are used as input parameters for a radiological impact assessment covered in our assessment report (Environment Agency, 2022d). Our conclusions in this report on the acceptability of the discharge estimates and proposed limits are made having regard to our wider assessment of the UK HPR1000 design. The concern raised in this comment regarding accidents is similar to that raised in UKHPR1000-026 and the Environment Agency’s response to that is provided above.

Solid waste, spent fuel and disposability

We received response UKHPR1000-009, which requested further information with regard to the comparison of solid waste discharges arising from the UK HPR1000 with other PWRs. The inventory for the UK HPR1000 has been derived from OPEX from the operation of PWRs in China. In addition, RWM has noted within its assessment that the HAW waste arising from the UK HPR1000 is considerably less than that for other GDA PWRs that RWM has assessed. However, it should be noted that the waste management practices could be different for each of the PWRs. Also, the operating conditions of the PWRs will be different and therefore any direct comparison with other PWRs would have significant uncertainties associated with the volume of wastes that would be generated. However, it is noted that the types of wastes are similar to those for other PWRs. We also note within section 4 of our solid waste assessment report, AR05 (Environment Agency, 2022e), that a number of improvements are being made to the UK HPR1000 to minimise the amount of waste that will be produced both during the operation of the reactor and when it is decommissioned. For example, the ion exchange beds within the UK HPR1000 will have a greater capacity to hold radioactivity than those that have been applied in China, which will lead to a smaller volume of ion exchange waste.

We note that the same response (UKHPR1000-009) questions the fact that on-site storage will be required until a GDF is available, and that the disposal of SFAs has the potential to affect the bentonite buffer around the GDF. The RP proposes to begin transferring HAW to a GDF in 2130. Until then, on-site storage of the ILW waste will be required. For SFA arising from the UK HPR1000, these will not be transferred to a GDF until 2145 at the earliest. Therefore, on-site storage will be required until then. We and ONR will continue to regulate on-site storage of ILW wastes and SFAs until all wastes are transported to a GDF. The provision of a GDF is a matter for government policy and this is described within the document ‘Implementing Geological Disposal’ (BEIS, 2018). Any alternative solution to a GDF is out of the scope for GDA.

With regard to the impact of the thermal output from the SFAs, on the barriers within a GDF, RWM has addressed this as part of its assessment. We discuss this within section 5.4.5 of AR05 (Environment Agency, 2022e).

We received response UKHPR1000-011, which requested further information on the existence and capacity of the supply chain to further minimise the disposal of radioactive waste to the LLW repository and a GDF. The response also raised a concern about the implementation of a GDF, which we have addressed in our response to UK HPR1000-009

above and within section 5.4.1 of AR05. As part of the GDA assessment, the RP has obtained disposability advice from both LLWR Ltd and RWM. In both cases, both parties are confident that the wastes arising from the UK HPR1000 will be disposable. LLWR Ltd operates a waste services contract, where waste treatment technologies within the supply chain can be utilised. This has yet to be developed for a GDF, due to the fact that the UK is still in the early stages of implementing such a facility. However, the NDA and the current sites within the UK continue to assess and develop options for the treatment of HAW, and as part of this they will have to demonstrate that the waste arisings have been minimised. For GDA, the scope ensures that only technologies that are currently available are used to treat the wastes arising from the UK HPR1000. We have assessed the RP's optioneering exercises, for both conditioning and packaging of the wastes, and are content with the options chosen for GDA.

We received response UKHPR1000-014 seeking assurances that our scrutiny of RWM's advice will be rigorous and that we will have assessed the issues with regard to the long-term storage requirements for the SFAs. We have scrutinised the RP's submission to gain confidence that the waste will be disposable to a GDF. Safe storage on site is regulated by ONR. We have assessed RWM's advice and are content with the conclusions that it has reached. We discuss this within section 5.4 of AR05. As part of our assessment, we have referred to RWM's generic disposal system safety case (gDSSC) and the supporting documentation as part of our assessment of RWM's disposability assessment for GDA. We have used our joint guidance on higher activity waste on site and our knowledge of previous disposability assessments for similar wastes. We have also, when necessary, sought further information from the RP and RWM with regard to their submission and assessment. As highlighted within section 5.4.1 of AR05, the disposability assessment for GDA is the first step in a multi stage process for assessing the compatibility of the RP's proposals for conditioning the HAW within a future GDF. In addition, as part of our ongoing regulatory remit, we will continue to assess a future operator's proposals to RWM with regard to the conditioning and packaging of the HAW arisings from the UK HPR1000. We note that the uncertainty associated with the decommissioning wastes, at present, will be greater than that for the operational wastes. However, the RP has used its knowledge of its reactor to provide a reasonable initial estimate of the decommissioning waste inventory. This will be refined during the operational phase of the reactor, as more information becomes available and will be available for the disposability assessments at the siting stage. We address the query with regard to the long-term storage of the fuel within section 5.3.1 of AR05. Further information on government policy regarding the GDF can be found in section A7.4.4.

Response (UKHPR1000-014) also requests additional information with regard to a number of additional areas: These are:

- whether a GDF can accommodate the wastes that will arise from the UK HPR1000
- whether there will be resources, technology and controls necessary to maintain HAW and spent fuel safely in interim storage until a GDF is available
- what the conditions will be like on a low-lying site (generic or Bradwell) vulnerable to inundation storm surges, coastal and processes

With regard to the query about whether the GDF can accommodate the waste arisings from the UK HPR1000, we have discussed this within sections 5.4.3 and 5.4.4 of AR05.

ONR is the lead regulator for the storage of wastes on site. Therefore, it will be the lead authority on assessing whether the proposal for the storage of HAW on site is acceptable from a safety perspective. We have reviewed the information the RP provided from an environmental view and we are content with what the RP has proposed for GDA. More information will be provided at the site-specific stage, with further information provided on aspects such as specific technologies, waste acceptance controls and resources. We will assess whether any of this information will impact on the environment as part of our ongoing regulation.

With regard to the query about an assessment of the conditions on a low-lying site and the implications this will have on the storage of the waste, this is a site-specific issue. This has not been assessed as part of GDA, as it is out of scope.

We also note that response UKHPR1000-014 highlights the uncertainties that exist with regard to the implementation of a GDF, and questions our conclusions regarding the wastes that are planned to be disposed of to a GDF. It is government policy that we will have a GDF and we are working to that assumption in GDA. At the time this point was raised we did not have the RWM assessment and it was noted as a potential GDA Issue at the time of consultation. Now that we have received and reviewed that information, we note that a number of issues have been raised. However, as the aim of the disposability assessment is to provide confidence that at least one option can lead, in principle, to a disposable package, we are content that the RP has provided this for GDA. It should be reiterated that the disposability assessment for GDA is the first stage in a multi-stage process. A future operator will need to address all the issues that RWM has raised, as part of the GDA disposability assessment, to obtain a letter of compliance.

Consultation response UKHPR1000-014 has also raised a series of questions with regard to the decommissioning wastes that will arise from the UK HPR1000. In particular, it raises the following queries:

- that no reactor in China has been decommissioned so far and therefore raises concerns about the available OPEX
- whether there are any materials where currently there is no solution with regard to disposal
- about the overall assessment the Environment Agency made and why we are not willing to provide an overall statement on the assessment of the decommissioning of the UK HPR1000

We agree that currently no reactors in China have been decommissioned. However, internationally there are a number of PWRs that have been decommissioned and the UK HPR1000 would present similar challenges to these reactors. In fact, as the RP has considered decommissioning as part of the design of the UK HPR1000, it is our view that this will lead to a reactor that will produce less wastes at the time of decommissioning, compared to older PWRs. The RP has reviewed the OPEX available internationally with

regard to dismantling the plant and decontaminating the reactor. The RP has applied this knowledge to the decommissioning plan for the UK HPR1000. The RP's approach to decommissioning the UK HPR1000 is based on currently available technologies. However, the UK HPR1000 will not be decommissioned for a considerable time and therefore new technologies and approaches to decommissioning such reactors will have been developed. A future operator will continue to review its decommissioning plan during the operational phase of the reactor's life cycle, and we would expect this as part of our ongoing regulation of an operator. We are content that what the RP has provided is acceptable for GDA.

We note that the same response highlights the decommissioning experiences at Bradwell A. Bradwell A has twin Magnox reactors, designed and constructed in the early days of the UK nuclear programme that are very different to a PWR. PWRs are more common around the world and, as stated previously, have been decommissioned. Therefore, the use of Bradwell A as an example, although we note the concerns raised, is not necessarily a suitable comparison, as, for example, the fuel element debris that has arisen at Bradwell A will not be a waste stream for the UK HPR1000. In addition, the management of the wastes and spent fuel during the operation of the UK HPR1000 will be different to that which was implemented for Bradwell A.

Our assessment has not identified any materials that cannot be disposed of. However, there is always the possibility that during operations additional wastes could be identified. These would need to be captured by a future site operator as part of the waste inventory. A future site operator will then need to seek advice from RWM or another competent authority with regard to the disposal of any new wastes identified. We note that RWM has highlighted within its disposability assessment that particulate matter arising from cutting operations during the decommissioning of the UK HPR1000 will need to be conditioned and packaged in a form suitable for disposal. The RP has not done this for GDA, as knowledge of the actual cutting tool to be deployed will be needed.

We received response UKHPR1000-015 with regard to the implications of the disposal of high burn up fuel within the GDF. RWM has assessed the impact of high burn up on a GDF and we have discussed this within section 5.4.4 of AR05. RWM will continue to review this as it moves towards the implementation of a GDF at a specific site(s).

We received a comment (UKHPR1000-017) with regard to interim store design being at a conceptual level and that no real detail in the design has been put forward and assessed. ONR is the lead regulator for the safety and storage of waste packages on site and therefore will review the design of the stores from a safety perspective. For GDA, we only expect the ILW store to be at the conceptual level of detail and that further information will be provided at the detailed design stage. Sections 5.2.5 and 5.3.1 of AR05 provide additional information of our assessment, but our focus is primarily on discharges (but discharges from the conceptual stores are out of GDA scope) and ensuring that the wastes remain disposable. We are content with the information that the RP has provided for GDA with regard to our regulatory remit.

We note the response also highlights the fact that currently waste from other Magnox Ltd sites is accepted at Bradwell A. This is out of scope for GDA, as this is a generic assessment and does not consider a specific site or sites, therefore this issue cannot be addressed at the GDA stage.

We received a comment (UKHPR1000-018), which sought further information on the timeline for storage of ILW and spent fuel on the site. The assumption within GDA is that the stores will be designed to store wastes for at least 100 years. The RP has proposed that the transfer of wastes to a GDF will begin in 2130. This is aligned with the current plan that RWM is working to, that low heat generating waste (LHGW) from the nuclear new build programme can begin being transferred to a GDF from 2100, and SFAs can begin being transferred from 2145. Section 5.4 of AR05 provides additional information regarding the disposal of wastes and SFAs. We also note that the response queries whether it is the operational lifetime that is being discussed. This is not the case. It is the lifetime of the reactor, which includes the decommissioning phase.

Response UKHPR1000-018 sought further information with regard to the activities of the wastes. This information is presented within AR05 Appendix 4 and reproduced here in Appendix 8.

Response UKHPR1000-019 also sought further information on the timeline for interim storage. We have already addressed this as part of our response to UK HPR1000-018 and within section 5.2.5 and 5.3.1 of AR05.

We received responses UKHPR1000-021 and UKHPR1000-026, which requested further information on the availability of the GDF. We have provided this information within section 5.4 of our report and in response to UKHPR1000-009 above.

We received a response UKHPR1000-027 questioning whether any of the potential GDA issues that we raised in our consultation document could have been closed during GDA. We have dealt with each of the potential GDA Issues within our report (AR05) and these can be found within sections 5.3.1, 5.3.2 and 5.4 of AR05. There is also a summary in Appendix 12 of this report. We conclude that the issues can be closed. In one case, we have raised an Assessment Finding so that a future operator continues to address this area. We also note the same response questions that we raised a potential GDA Issue with regard to the disposal of ICIAs. The issue was raised as the retrieval and storage strategy was not clear, and there could have been an implication for the disposal route and advice if the ICIAs had been decayed to LLW. However, this has now been addressed to our satisfaction for GDA.

We received response UKHPR1000-037 querying whether the waste forms are acceptable to be handled at the UK's waste disposal facilities. The RP has received disposal advice from LLW Ltd and RWM. In both cases, the RP plans for a future operator to use packages and conditioning treatments, which are currently acceptable to both LLW Repository Ltd and RWM. In both assessments, a number of points have been raised that a future operator would need to address as part of its ongoing engagement with both disposal operators.

We received response UKHPR1000-043 that questioned the waste classification of the reactor pressure vessel (RPV). The RP has modelled the heat output from the RPV and it has concluded that the heat output is in the ILW range and does not need additional cooling. The heat output from the RPV has been modelled from 5 years to 100 years after the end of operations. Even at the point of generation, it is unlikely to be HLW. With regard to disposal, the RPV will be ILW at the time of disposal. It is more likely that potentially components of the reactor vessel internals (RVI) may be HLW at the point of generation. However, an operator will be able to refine the classification of the decommissioning wastes during the operational period of the reactor and the initial decommissioning phase.

Response UKHPR1000-043 also questions the use of incineration for treating the disposal of LLW resins. LLWR Ltd has assessed the use of this approach for the treatment of LLW resins and does not see this as an issue. However, the direct disposal of resins to the LLW disposal facility has not been ruled out. As highlighted within section 5.1 of our assessment report, AR05, there are some issues that will need to be addressed if the resin were to be disposed of directly to the facility. If incineration is selected for the resins, it will be carried out by a permitted operator who will need to comply with its permit and ensure that discharges to the atmosphere meet with the legal requirements. In addition, by incinerating the resins, the volume of waste that will need to be disposed of will be significantly less, which will align with the waste management hierarchy. A future operator would need to demonstrate that incineration is BAT.

The same response (UKHPR1000-043) questions the use of the 210L drum for a GDF. Within our assessment report (AR05) we do note that a 210L drum is not a suitable package for a GDF. RWM's assessment has been based on the 500L drum, which is an acceptable package for a GDF. However, there is a potential option that if the waste in a 210L drum did not decay to LLW, these drums would need to be over packed using a waste package that is compliant with a GDF. However, a future operator will need to obtain advice from RWM regarding this option.

The same response (UKHPR1000-043) also questions the storage of SFAs on-site and when they will be transferred to a GDF. We have already addressed a similar response as part of our response to UKHPR1000-009 above.

We note that the response (UKHPR1000-043) has also questioned the OPEX available with regards to the use of the $M5_{Framatome}$ cladding. This material has superseded another alloy called Zircalloy-4, which has been used over several decades for the cladding of PWR fuel assemblies. The RP has demonstrated that the properties of $M5_{Framatome}$ alloy perform as well, if not better, than the Zircalloy-4. Therefore, we are content that, based on the OPEX for both alloys, there is sufficient OPEX to support the RP's conclusions.

We received response UKHPR1000-047, which requests further information regarding the amount of spent fuel and the storage requirements. We have provided this information within sections 3.3 and 5.3.1 of our assessment report, AR05.

The same response has raised the issue of how we plan to address our potential GDA Issue on the SFIS requirements. We have addressed this within section 5.3.1 of our assessment report, AR05.

The comment also seeks further information in relation to what level of design knowledge and intellectual property is required to safely decommission the nuclear reactor and how this would be achieved by a party other than the RP. For GDA, the decommissioning of the UK HPR1000 is based on currently available technologies. Issues relating to intellectual property and knowledge transfer to allow a third party to decommission the UK HPR1000 are out of the scope for GDA. Some aspects of the arrangement for transferring information to a future operator are assessed as part of AR01 (Management for Safety and Quality Assurance [MSQA]) and will be considered further at the site-specific stage.

The same comment also asks whether RQ-UKHPR1000-0992 has been resolved. It has, and we provide our assessment within section 5.1 of AR05.

The same response asks about incineration on-site, but we have not stated within our report that incineration will occur on site. Incineration will be off-site and will make use of LLWR Ltd's waste services contract (see AR05, Appendix 4).

The same response asks about decommissioning and what will be left after 60 years. Decommissioning will not have begun while the reactor is still in operation and therefore, at the end of the 60-year period, the reactor will be as it was at the end of operations. However, over the next 18 years the site will be decommissioned back to an agreed state, which the RP has assumed will be a green field site. However, this would be a discussion for a future operator and its stakeholders to have in the future.

Sampling and monitoring

We received a response (UK HPR1000-017) from a Bradwell resident concerning the inclusion of an environmental monitoring programme during GDA. An environmental monitoring programme is not included within the scope of GDA due to the site-specific nature of such monitoring. The requirements for an environmental monitoring programme would be addressed at site specific permitting.

We received a response (UK HPR1000-043) concerning the management of the liquid waste treatment system within the discharge limits, and operator monitoring and independent sampling. The RP has provided reference values indicating statutory detection limits can be met using currently available systems. In meeting statutory requirements, the RP has indicated that compliance with the proposed limits is achievable. Also, in addition to sample collection, a continuous radiation monitor is provided in the liquid discharge line. If the system detects an elevated radiation level, it activates an alarm and closes an isolation valve to stop discharge to the environment. A manual valve is also fitted to enable the operator to stop the discharge if required. In response to the operator monitoring and independent sampling question, the RP has properly considered our requirements that we enforce through EPR 2016 (as amended) (UK Parliament, 2016),

both for self-monitoring of levels of radioactivity and provision of additional capacity to allow for independent verification of the discharges.

We received a response (UK HPR1000-047) concerning the lack of clarity of BAT and the provision of publicly available guidance, operational procedures for isolation valves and inclusion of an environmental monitoring programme during GDA. The principles of optimisation guidance (Environment Agency, 2010b) provides guidance to our regulators and to operators on optimising the management of generating and disposing of radioactive waste. Internal Environment Agency guidance on monitoring of radioactive discharges to atmosphere and water (Environment Agency, 2020c and 2020d) can be made available to anyone on request. The RP has been clear where the design has deviated from the guidance for the gaseous sample return line and demonstrated the impact is negligible, but with a beneficial reduction in solid waste at decommissioning. Operational aspects are addressed at the planning and permitting stage following the GDA stage.

Generic site and radiological impact to humans and wildlife

UKHPR1000-007 - The respondent noted that Public Health England (PHE) was reported to have stated "not all organisations use one in a million health detriments as a regulatory criterion for assessing acceptable risk", and that "work is going on about tolerability". We were asked what criteria will be applied to the UK HPR1000 and how any discrepancies in health detriment estimates will be resolved.

The assessment of the doses from discharges from the UK HPR1000 were compared with the dose criteria for the public used in the UK (dose limit and dose constraints). The doses were well below the dose limit and dose constraint. The dose limit and dose constraints are given in Schedule 23 of the EPR 2016 (UK Parliament, 2016). It is PHE’s role (since changed to the UK Health Security Agency) to provide advice on radiation protection to the UK and it endorsed the dose limit and dose constraints for protection of the public. PHE has not advised us of any discrepancies in health detriment estimates.

UKHPR1000-013 and UKHPR1000-014 - Both respondents raised a point relating to dose weighting factors. It was noted that relative biological effectiveness factors for wildlife were quoted, but there were none quoted for human dose assessment. The respondent was particularly interested to know what weighting factor was used for alpha activity.

We note that the radiation weighting factors identified in the question are for non-human species and are presented in ERICA report – Beresford et al., (2007) and the FASSET project - Prohl et al., (2003).

The radiation weighting factors for people are taken account of in dose coefficients. Dose coefficients used to calculate effective dose to the public were taken from ICRP-119 (ICRP, 2012). ICRP-119 is a compendium of dose coefficients which serve as a comprehensive reference for dose coefficients based on the primary radiation protection guidance given in the ICRP Publication 60 recommendations (ICRP, 1991). ICRP 60 presented radiation weighting factors (W_R) for use in radiation protection. Radiation weighting factors are a dimensionless factor to derive the equivalent dose from the absorbed dose averaged over a tissue or organ, and are based on the quality of the

radiation. Radiation weighting factors vary depending on the type of radiation and were published in ICRP-60 (ICRP, 1991). They were used in the derivation of dose coefficients presented in ICRP-119 (ICRP, 2012) and for clarity are reproduced in Table A7-2. Public Health England (PHE) provides advice in the UK on radiation protection including on the recommendations of the ICRP.

Table A7-2 Radiation weighting factors (W_R) used in dose coefficients for the public

Radiation type and energy range	W_R
Photons, all energies	1
Electrons and muons, all energies	1
Neutrons, energy <10 keV	5
Neutrons, energy 10 – 100 keV	10
Neutrons, energy >100 keV to 2.0 MeV	20
Neutrons, energy >2.0 MeV to 20 MeV	10
Neutrons, energy >20 MeV	5
Protons, other than recoil, energy >2 MeV	5
Alpha particles, fission fragments, heavy nuclei	20

UKHPR1000-014 – The respondent noted that the assessment was only based on a single unit, that the cooling systems were different to those proposed for Bradwell and that, although the generic site has parameters in common with Bradwell, it cannot be assumed to represent Bradwell. Also, they noted that the assessment does not take into account designated wildlife sites. The respondent thinks we need to be explicit on these points.

GDA is defined as being for one reactor only in section 3.2 of our assessment report AR07 (Environment Agency 2022g). If the reactor design is to be built and operated at a specific site, we cannot predict how many units a potential operator may choose to build. As part of an application for an environmental permit, an assessment of the impact of a planned power station would be made, which would allow for the number of reactors in the power station. Site-specific information would be used.

The inclusion of Bradwell specific parameters in the generic site does not suggest the generic site represents Bradwell, but these are included to ensure that the generic site is

sufficiently cautious that it will result in a bounding radiological impact assessment for GDA.

The impact of discharges on protected habitats and species would be required as part of a site-specific impact assessment if a permit is applied for. An assessment of impact on reference organisms at the generic site was made during GDA. Reference organisms in the assessment are consistent with species that will need to be protected in the UK. This is explained in more detail in section 3.3 of AR07 (assumptions about dose rate criteria).

UKHPR1000-018 – The respondent raised a concern that radioactivity would accumulate in the marine conservation zone around Bradwell, adding to that already discharged from Bradwell A.

While site-specific concerns are out of scope of GDA, the accumulation of discharges from other nuclear plants such as Bradwell A would be assessed during an application for a permit. In the case of Bradwell A, the radiological impact of past discharges is captured through monitoring of the environment and an assessment made by the operator and separately by the Environment Agency. The environmental levels and the radiological impact are reported in the RIFE report series. The impact of future discharges from Bradwell A was assessed when the permit was varied and the power station went into decommissioning. The assessment assumed that all future discharges occurred at the permitted limits - a cautious assumption. The modelling carried out assumes that discharges last for 50 or 60 years and include accumulation of radionuclides in the environment.

The accumulation of discharges from a new nuclear power station would be included in the assessment during an application for a permit. Discharges would be assumed to occur at the discharge limits set in the permit. The assessment will take into account the impact of past and future discharges from other nuclear power stations that are adjacent to the site.

The same consultation response (UKHPR1000-018) also raised a concern that our assessment does not consider ‘spikes’ in discharges.

The RP has made an assessment of the impact from short duration enhanced releases to atmosphere. These are summarised in Table 2c of our assessment report, AR07 (Environment Agency 2022g). An independent assessment of doses from short-term releases to atmosphere was also made and the results are presented in Table 4c of AR07. Doses to the public are in the range 6 to 10μSv, and vary slightly with age group (adult, child and infant groups). The doses are dominated by the inhalation of the plume and ingestion of foods. Most of the dose was from carbon-14.

UKHPR1000-019 – The respondent raised a concern that the preliminary assessment report listed so much outstanding information required to define the generic site.

We note that the information listed as missing was related to the findings from our Initial Assessment (Environment Agency, 2018a) and not information that was missing as part of our detailed assessment to reach our preliminary conclusions for consultation. This information has been provided during our detailed assessment and no information required for GDA remains outstanding.

UKHPR1000-021 – This respondent raised concerns that impact assessment studies are always over optimistic to ensure projects proceed.

We are clear throughout this report that discharge estimates and impact assessments made in GDA are cautious. There is overestimation in several areas. The first caution is the assumption that the discharges are made at the proposed permit limits. The proposed permit limits allow for expected events that may result in higher releases which could occur at some point in the lifetime of the reactor. Therefore, basing the assessed discharges on expected permitted limits will be a broad overestimate as actual discharges during normal operation will be less than the proposed permit limits.

Other factors are the assumptions in the assessment about how much local food is eaten, the types of foods eaten and how long people are present either indoors or outdoors. For GDA, the habits data used is based on high intake data taken from UK generalised habits data. This data is generally conservative – resulting in a cautious assessment.

UKHPR1000-026 – This respondent raised several concerns relating to the consequences of accidents at nuclear sites.

We only assess impacts from discharges from normal operations which include an allowance for expected events/reasonably foreseeable events. ONR assesses the impact from releases from accidents (accident consequence).

UKHPR1000-043 – This respondent raised multiple points as follows:

a) There are too many unknowns and our language was too vague.
b) Information for the generic site was missing.
c) The RP's model results were 'better' than the Environment Agency's independent assessment.
d) The generic site and habit data does not represent Bradwell.
e) No indication is given how the figures of 20 to 23uSv/y were derived.
f) The assessment considers only a single unit without consideration of any adjacent reactor.

We will address each point in a separate paragraph below:

a) Our assessment is carried out against the standards and guidance referred to in section 2.4 of our assessment report AR07 (Environment Agency 2022g). The use of terms such as 'adequate' and 'acceptable' indicate that the required standards have been met.

b) As noted in our response to UKHPR1000-019, we note that the information listed as missing was related to the findings from our Initial Assessment (Environment Agency, 2018a). As part of the normal GDA process, additional information was requested through several RQs. Subsequently, the RP submitted a revised generic site document for detailed assessment which contained the information requested in the RQs. All required information has now been received.

c) The assessment the RP made and our independent assessment were carried out by predicting concentrations in the environment using models informed by input data. The concentrations were used with information on habits to make an

assessment of the doses to the public. Some differences in outcomes are expected where dose assessments are made independently. The outcomes from the assessments are similar but not identical. The differences in outcomes are because of slightly different input data and assumptions about which habits data to use.

d) The generic site description is not fully representative of Bradwell, but takes account of the Bradwell site parameters. The RP has set up the model based on some of the input data that are characteristic of the Bradwell environment. However, the habits data used were a combination of generic UK data and habits observed around the Bradwell site. Generalised habits data include consumption of locally produced milk. However, consumption of local milk is not observed currently around the Bradwell site. In some cases, habits data from the Bradwell site were included if there was no equivalent generic data. Therefore, the assessment could be considered to be similar to Bradwell with additional conservative (cautious) aspects. If a new power station were to be built and operated in England using the UK HPR1000 reactor, the operator must apply for a site-specific environmental permit. In that case, a site-specific assessment of doses to the public will be required to support the permit.

e) The dose method the RP used is described in its submission in PCER07 (GNSL, 2021u). We also carried out our own assessment (Environment Agency, 2021b). The results were similar. The dose methodology the Requesting Party adopted has been assessed in this report against the published guidance. The guidance is laid out in section 2.4 of AR07 and includes Regulatory Environmental Principles, principles for the assessment of prospective dose and other technical guidance. These documents contain the methodologies used to derive the reported dose.

f) The assessment in GDA is for a single reactor. This is because we cannot predict how many units a potential operator may choose to include at a particular site. However, we have assessed the known worst case site, which would be adjacent to Sellafield. The total dose for a UK HPR1000 reactor adjacent to Sellafield would be below the dose limit for the public.

UKHPR1000-044 - The Food Standards Agency (FSA) has reviewed the RP's Pre-Construction Environmental Report (PCER) and proposed radioactive discharge limits. FSA has carried out its own preliminary dose assessments against the proposed radioactive discharge limits and considered the impact on the food chain to inform its response to this consultation. FSA agreed with our preliminary conclusion that the radiation dose to people will be below the UK constraint for any single new source of 300uSv/y. As such, there will not be an unacceptable impact on the food chain for sites that meet the generic site characteristics. However, the FSA will consider this in more detail on a site-specific basis in its role of advising the Environment Agency in permitting decisions under the Environmental Permitting Regulations.

We note that the Food Standards Agency has assessed that the radiation dose to people will be below the UK dose constraint. The Food Standards Agency has used its model of

the food chain. Its assessment has provided a third assessment of impact and is consistent with the RP's and our assessment.

UKHPR1000-045 - The response from Colchester Borough Council asks how the Council can be reassured that, if approved, GDA for the UK HPR1000 at the generic site has the parameters suitable for specific sites such as Bradwell.

The generic site description takes account of the Bradwell site. The Requesting Party has set up the model based on some of the input data that are characteristic of the Bradwell environment. However, the habits data used were a combination of generic UK data and habits observed around the Bradwell site. In some cases, data from the Bradwell site were included if there was no equivalent data in the UK generalised habits data. Some of the environmental input data to the model are conservative (cautious). Therefore, the generic site taking account of Bradwell parameters will be a conservative option of the sites outlined in EN-6 (DECC, 2011b and 2011c). However, if an application were made to deploy UK HPR1000 reactors at Bradwell, the applicant would need to submit a full site-specific impact assessment as part of that application.

UKHPR1000 047 – This respondent asked:

a) What ecological parameters are used in the GDA to determine that the estimated discharge figures are acceptable?
b) What level of sensitivity and ecological protections are built into the GDA limits, due to the nature of some of the proposed UK sites?

The proposed limits on discharges that the RP has estimated are based on data obtained during reactor operations. The assessment of ecological impact from discharges made at these proposed limits has been presented in the the RP's submission PCER07 (GNSL 2021u) and is assessed in section 3.3 of AR07 (Environment Agency, 2022g). The dose rates to non-human species are well below the dose rate criterion and screening values. The assessment is conservative (cautious) as it is based on discharges at the proposed limits, but, in reality, discharges would be expected to be below permitted limits. The RP's submission and our independent verification shows that the dose rates to reference organisms in the terrestrial and marine environments are 0.15µGy/h or less. This is well below the dose rate criterion of 10µGy/h. There is a large margin between the dose rates calculated and the dose criterion, which indicates a very low radiological impact on wildlife. It is the outcome of this assessment that indicates that the proposed limits are acceptable.

UKHPR1000-047 also asked for clarification on the generic ecological parameters set in the GDA to account for highly protected terrestrial and marine ecological sites.

The RP assessment made uses of a set of reference organisms that are consistent with species that will need to be protected in the UK. The reference organisms are assumed to be located in the environment defined by the generic site. The locations are close to the site where the environmental concentrations and dose rates will tend to be at their highest. Therefore, this approach is conservative and leads to a cautious assessment.

The assessment is based on a generic site, therefore specific protected habitats cannot be identified until we receive a site-specific permit application.

This respondent (UKHPR1000-047) was also concerned that the assessment is based on a generic dose output and that it does not consider all isotopes present in the radioactive wastes.

We confirm that the basis for determining radiological impact does take into account the type of radioactive waste. The radionuclides present in the discharges have been identified and assessed. This model and methodology takes into account the environmental behaviour of each radionuclide and the radiological impact (dose) from each radionuclide. The RP's submission (GNSL, 2021u) shows the dose from each radionuclide. The single dose we report is the sum of all the individual radionuclides.

This respondent (UKHPR1000-047) was concerned that the generic site was not applicable to Bradwell as this is an estuarine site.

The assessment the RP provided (GNSL, 2021u) has made use of models and data that allow calculation of annual dose arising from discharges to the estuarine environment. The RP has used marine data for the estuary that is close to the current Bradwell site. Therefore, the generic assessment is valid for an estuarine environment. However, if an application were made to deploy UK HPR1000 reactors at Bradwell, the applicant would need to submit a full site-specific impact assessment as part of that application.

UKHPR1000-050 – This respondent raised 2 points:

a) Whether discharges that accumulate over time are really 'acceptable'.
b) That the assessment does not consider discharges from maintenance failures and unexpected accidents.

Firstly, the modelling of the dispersion of radionuclides from discharges assumes 60 years of discharges. The model used includes accumulation of radionuclides in the environment from the discharges. The dispersion of radionuclides discharged as gases, mists and dusts to atmosphere and liquids to the marine environment have been modelled. The assessment is made assuming the discharges are at the proposed limits, and the resulting doses are below the dose limit and constraints for the public.

Secondly, in the proposed limits, allowance has been made for discharges from normal operations, including maintenance, inspections and testing, and also includes expected events that may lead to an increase in discharge. Expected events are those that can be expected to occur over the lifetime of the plant. An example would be occasional fuel pin cladding leaks. We have assessed the impact of these discharges by comparing doses and dose rates with the dose limit for the public and dose constraints for the public and dose rate criteria for non-human species. The doses and dose rates are well below the dose criteria.

ONR is responsible for regulating nuclear safety, which includes ensuring the licensee has and implements adequate arrangements for dealing with any accident or emergency arising on the site and their effects.

Other environmental regulations

Water use and abstraction

We received comment UKHPR1000-011 regarding water use and abstraction.

The comment expressed a view that once-through cooling is not viable at the Bradwell site and went on to say that indirect cooling could not be considered BAT for this site. Concerns such as the site-specific selection of cooling options are outside the scope of GDA. However, the RP has proposed once-through cooling for the UK HPR1000 GDA based on the generic site. While Bradwell has been proposed as a site for the first deployment of the UK HPR1000, GDA is based on a generic site. Section 3.2.4 of our assessment report, AR08 (Environment Agency, 2022h), explains that once-through cooling can be considered BAT for the generic coastal or estuary site, but also that any other cooling water system could be considered BAT for any given site. The RP has left it open for a future operator to determine BAT for cooling based on the characteristics of the specific deployment site. We will use site-specific information and consider guidance current at the time of a site-specific application to determine whether the operator's proposals are BAT for a particular location.

We received comment UKHPR1000-014 regarding water use and abstraction.

Section 3.2.4 of our assessment report, AR08, explains that the once-through cooling system proposed for the UK HPR1000 GDA can be considered BAT for the generic site but also that any other cooling water systems (listed in AR08, section 3.2.4) could be considered BAT for any given site. The RP has left it open for a future operator to determine BAT for cooling based on the specific deployment site. We will use site-specific information and have regard for guidance current at the time of a site-specific application to determine whether the operator's proposals are BAT for a particular location.

The comment raises concern that there has been no thermal impact modelling carried out in GDA. This issue is not covered in any depth at GDA because meaningful modelling cannot be carried out without detailed information on the behaviour of the receiving surface water environment. For this reason, it was agreed to be out-of-scope of this GDA (see AR08, Executive summary and section 3.2.2 'Assumptions'). This is an important area that would be assessed at a site-specific stage when the information necessary for this to be done would be available.

Comment is also made about our assessment of the potential impact on fish and invertebrates during GDA. This is an area that requires detailed information on the environment around the site, which is not available at GDA for a generic site. The assessment for GDA ensured the RP was clear on the importance of this issue and that it

is aware of what needs to be taken into consideration in the choice of fish deterrent and recovery and return systems for site-specific permitting.

While we understand the concerns raised and the desire for the Environment Agency to assess the environmental impacts at Bradwell, GDA is based on a generic site. We have carried out an appropriate assessment for the GDA stage.

In addition, reference is also made in this comment to visual impact and emissions to air and sea from a hybrid cooling design at the Bradwell site. These aspects are outside the scope of GDA as they are site-specific. This GDA is for a once-through cooling system at the generic site. It should also be noted that visual impact is not within the Environment Agency's remit and is a matter for the relevant planning authority.

We received comment UKHPR1000-027 regarding water use and abstraction.

The comment suggests that we should consider the difference between UK HPR1000 and other PWR technologies in terms of water abstraction. This GDA is for the UK HPR1000 design at a generic site location. Comparison with other technologies and consideration of the potential sites selected for development are outside of the GDA scope. However, generally we would expect PWRs to have similar requirements for cooling water where once through cooling is being used. This assessment applies our well-established abstraction licensing regime to this design to conclude whether an abstraction licence may be required for the generic site (which, in this case, is a coastal or estuary location).

Discharges to surface water

We received comment UKHPR1000-011 regarding discharges to surface water.

The comment queried whether a GDA decision will remain valid if an alternative to direct (once-through) cooling is chosen. This aspect is covered in our assessment report, AR08 (Environment Agency, 2022h) in section 3.2.4 'Cooling water system requirements'. If proposals were to come forward from a future operator for a specific site, we would require them to address any changes to the GDA design arising from the site characteristics or the operator's detailed proposals.

We received comment UKHPR1000-014 regarding discharges to surface water.

The comment asks us to consider asking the RP for more information on the potential acceptability of emissions and discharges using an estuarial site as the basis for assessment. The screening approach for the environmental impact assessment is described in section 4.2.4 of AR08. The screening assessment the RP carried out used our guidance to compare predicted discharges against environmental quality standards (EQSs). The EQSs used in this assessment were for 'estuaries or coastal waters' so are appropriate for the generic site. More detailed modelling can only be carried out when more information on the environment at a specific site is available. Our Assessment Finding 41 is included to highlight this.

The comment also states that discharges should not be allowable into a marine conservation zone (MCZ). The generic site assessed for GDA was not an MCZ, so this has not been considered. If a MCZ has been designated at any future specific location chosen for the UK HPR1000, then it would be considered appropriately in our determination of an application for a water discharge activity permit.

The comment also questions how we could issue a statement of design acceptability (SoDA) without considering discharges into the 'specified estuarial site', and that considering a generic site for a generic design assessment is 'inadequate'. The scope of the GDA is well set out and is limited to the generic site presented by the RP. All of the specific aspects raised in the comment (such as thermal impact, MCZ) are all part of our assessment at a site-specific permitting stage.

We received comment UKHPR1000-043 regarding discharges to surface water.

The comment raised a concern that using hydrazine introduces additional toxicity. We have covered the use and treatment of hydrazine during GDA, and our assessment is described in section 4.2.4 'Environmental impact assessment' of our assessment report, AR08 (Environment Agency, 2022h). In response to our Regulatory Queries, the RP has provided a number of ways in which hydrazine could be managed to minimise its discharge. The outcome from the GDA process is that hydrazine has been highlighted as a substance requiring particular attention at the site-specific permitting stage.

We received comment UKHPR1000-043 regarding discharges to surface water.

The comment raised a concern about the amount of detail in the assessment carried out for the list of substances on page 107 of the Consultation Document (Environment Agency 2021a). The extent of the screening assessment is explained more fully in section 4.2.4 of our assessment report, AR08. The list referred to in this comment includes those substances that are screened out of the assessment carried out for GDA. It should be noted that Assessment Finding 41 requires that all substances would be assessed more fully at site-specific permitting stage.

Discharges to groundwater

We received comment UKHPR1000-043 regarding discharges to groundwater.

The comment states that there is insufficient evidence that discharges to groundwater would not be polluting. It is confirmed in section 5.2.3 of our assessment report (AR08) that there will be no intentional discharges to groundwater, therefore a permit will not be required. In GDA, we ask the RP to focus its response on how leaks and spills would be prevented from entering groundwater. The RP has appropriately described the use of primary, secondary and tertiary containment.

Operation of installations

We received UKHPR1000-014 regarding the operation of installations.

The comment acknowledges that further work will be required at the site-specific permitting stage, but considers this to be inadequate. The site-specific nature of the topics covered in this report means that further work would have to be carried out at each site-specific permitting stage. Assessment Finding 42 requires a BAT assessment for the specific combustion plant chosen. Assessment Finding 43 requires the discharges to air from the combustion plant to be risk assessed at the site-specific stage.

We received comments UKHPR1000-041 and UKHPR1000-047 regarding the operation of installations.

The comments state that diesel generators should not be used due to emissions, and that alternative cleaner fuels should be sought. The diesel generators are required for nuclear safety and need to respond immediately to a loss of power if required. One of the main considerations is the availability of supply in such situations, and diesel fuel stored on-site provides a more robust supply when compared to other currently available options. Diesel has been proposed and assessed at GDA as the most appropriate fuel for the back-up generators, but it should be noted that the final choice is a site-specific choice for an operator to make. The site-specific choice must be demonstrated to be BAT at the time of a site-specific application, and Assessment Finding 42 highlights this.

Comment UKHPR1000-043 raised a similar concern to the one above, but also expressed concern that the modelling for EDGs showed levels exceeding requirements. The Environment Agency screening tool used for this assessment is noted as being very conservative. It is generally used at site-specific permitting to screen out substances that are genuinely insignificant and highlight those that require additional consideration. Any substance that doesn't screen out using this tool is usually required to be subjected to more detailed air dispersion modelling.

It is not possible to carry out meaningful detailed modelling at GDA because the necessary input parameters for the air dispersion models are not available for a generic site. The levels, "exceeding requirements" were picked up during GDA, and we asked the RP to carry out a detailed sensitivity analysis to better understand the conservativeness of the screening tool. This work met our expectations and is described more fully in section 6.2.6 of our assessment report, AR08 (Environment Agency, 2022h). In addition to this, we also included Assessment Finding 43 to ensure a detailed assessment of emissions to air from the combustion plant is carried out at the site-specific permitting stage.

COMAH

We received comment UKHPR1000-014 regarding COMAH.

The comment raises concerns in relation to nuclear accidents and the release of radioactivity. At GDA this area of assessment lies with ONR. The COMAH Regulations are concerned with major accidents associated with the release of non-radioactive hazardous chemicals. Our assessment of the UKHPR1000 design in relation to the COMAH Regulations is covered in detail in section 7 of our assessment report, AR08 (Environment Agency, 2022h).

We received comment UKHPR1000-021 regarding COMAH.

The comment stated that containment of hazards within the boundary fence is an unrealistic scenario. From the assessment carried out for GDA, our conclusion is that the UKHPR1000 will not fall under the COMAH Regulations. Assessment Finding 44 requires a future operator to keep quantities of COMAH dangerous substances under review. If any storage quantity thresholds are ever exceeded then the site will fall under COMAH regulation. At this point the potential impacts of a COMAH major accident (defined in the introductory paragraph of section 7 of our assessment report, AR08) both on and off-site will be assessed and the future operator will be required to take all measures necessary to reduce the risk to the environment and people.

We received comment UKHPR1000-027 regarding COMAH.

The comment questioned what powers the Environment Agency has to consider the control of major accidents. In England, the COMAH Competent Authority is the regulator, which is made up jointly by the Environment Agency and the Office for Nuclear Regulation (ONR). This requirement for a COMAH Competent Authority is set down in the COMAH Regulations 2015.

We received comment UKHPR1000-043 regarding COMAH.

The comment raised a concern that the strategy to monitor a change of status (under COMAH) is unclear. The strategy will be the responsibility of future operators to develop and, as such, does not currently exist. When a site becomes subject to COMAH the regulations place the responsibility to notify the COMAH Competent Authority onto the operator, failure to do so is a breach of the regulations. Assessment Finding 44 is intended to highlight to a future operator that it must keep its chemical inventories under review to ensure the point at which any of the COMAH thresholds are crossed is identified. This would trigger the requirement to notify the COMAH Competent Authority. This type of inventory management is common throughout many industrial sectors that store and use COMAH dangerous substances (for example, hazardous waste or chemical manufacturing industries).

Fluorinated greenhouse gases and ozone depleting substances

We received comments UKHPR1000-039 and UKHPR1000-040 regarding fluorinated greenhouse gases (F-gas) and ozone depleting substances (ODS).

The comments question why F-gases and ODSs are proposed to be used at a future site. Our conclusion in section 8.3 of our assessment report, AR08 (Environment Agency, 2022h) states that no ODS will be used in the design. The proposed use of F-gases in the UK HPR1000 design is similar to the approach currently taken in other industry sectors for the purposes of refrigeration, fire protection systems and as insulating gases. Section 8.2.3 of AR08 (‘Equipment using F-gas’) explains how some F-gases are being phased out over time and that alternatives will need to be sought. The RP is clear that the choice

of gases is a site-specific matter, and Assessment Finding 45 is intended to ensure any gases chosen by a future site operator are legally permitted for use at that time.

We received comment UKHPR1000-043 regarding fluorinated greenhouse gases (F-gas) and ozone depleting substances (ODS).

The comment stated that the F-gases should be independently monitored and catalogued. We would expect a future operator to work within the regulatory regime in place at that time, and any failure to do so could result in enforcement action.

We received comment UKHPR1000-047 regarding fluorinated greenhouse gases (F-gas) and ozone depleting substances (ODS).

The comment raises concern that the Environment Agency hasn't asked for alternatives to be specified. Identifying alternatives to F-gases is an ongoing process that any future operator would have to adhere to. Section 8.2.3 of our assessment report (AR08) discusses the potential alternatives that the RP proposed, but is clear that the choice of gases for refrigeration, fire protection systems and as insulation are decisions for a future operator, who would be required to comply with the legislative controls in place at that time. Assessment Finding 45 is included to ensure that this is done.

A7.3 Responses that fall outside of the scope of our GDA remit

A7.3.1 Site-specific concerns relating to planning

One respondent (UKHPR1000-003) noted that if a site were located within the internal drainage district of any of our member internal drainage boards (South Holland, King's Lynn, Norfolk Rivers, Broads (2006) or East Suffolk Internal Drainage Board) then the Board's byelaws will apply. They also noted that although the byelaws are separate from planning, the ability to implement a planning permission may be dependent on the granting of these consents. They recommended that the required consent is sought prior to determination of the planning application.

While we agree with the point made, GDA assesses a generic reactor design and is not related to any specific site. Site-specific issues such as local byelaws required for planning consent are out of scope of GDA. There will be opportunities for stakeholder engagement around the planning process and these would be the appropriate times to engage on this matter.

A7.3.2 Site-specific concerns relating to Bradwell B

Nineteen respondents raised concerns that were specifically related to the proposed development at Bradwell B. These are listed below:

UKHPR1000-004, UKHPR1000-006, UKHPR1000-008, UKHPR1000-011, UKHPR1000-014, UKHPR1000-015, UKHPR1000-016, UKHPR1000-017, UKHPR1000-018, UKHPR1000-019, UKHPR1000-034, UKHPR1000-036, UKHPR1000-039, UKHPR1000-041, UKHPR1000-043, UKHPR1000-047, UKHPR1000-048, UKHPR1000-049, UKHPR1000-051 and UKHPR1000-052

These points relate primarily to site-specific matters that are not assessed at the GDA stage, but during environmental permitting and site licensing once proposals for a specific site have been brought forward. This is because we will require detailed site-specific information to be able to carry out a suitable assessment.

Some of the site-specific issues raised are assessed under environmental permitting, which includes more locally-focused consultation on both the application and the decision. Others are captured under the planning process and further engagement opportunities will be part of the Development Consent Order (DCO) process.

The site-specific points raised include:

- impact on wildlife: including impact on designated areas such as marine conservations zones, impact on fish and use of fish deterrent systems (UKHPR12000-004, 006, 014, 016, 018, 034, 039, 041, 043, 047, 049 and 052)
- impact on known grave sites (UKHPR1000-004)
- concerns over the scale of the development and visual impacts (UKHPR1000-006, 019, 034, 036, 039 and 051)
- transport and traffic issues (UKHRP1000-006, 008 and 039)
- noise issues (UKHPR1000-008)
- transmission lines (UKHPR1000-006)
- the visual impact of cooling towers and stacks (UKHPR1000-008, 011, 014, 017 and 043)
- water supply and abstraction concerns (UKHPR1000-011, 039, 041 and 048)
- coastal flooding related to sea level change and climate change (UKHPR1000-014, 015, 018, 041 and 052)
- impact on the local fishing industry (UKHPR1000-006)
- no environmental monitoring programme (UKHPR1000-017)
- quantity, location and duration of radioactive waste storage on site (UKHPR1000-018, 019, 039 and 047)
- site-specific impact of discharges to the Blackwater Estuary (UKHPR1000-018 and 039)

A7.3.3 Ongoing regulation

Seventeen responses raised a concern relating to the fact that GDA is not a complete and finalised assessment or aspects related to ongoing regulation. These are listed below:

UKHPR1000-005, UKHPR1000-006, UKHPR1000-011, UKHPR1000-014, UKHPR1000-015, UKHPR1000-017, UKHPR1000-018, UKHPR1000-019, UKHPR1000-021,

UKHPR1000-029, UKHPR1000-038, UKHPR1000-039, UKHPR1000-043, UKHPR1000-045, UKHPR1000-047, UKHPR1000-048 and UKHPR1000-050

Respondents noted that they were concerned that we had repeatedly stated that information was not available, that there were remaining uncertainties, that language and guidance was vague or we were not assessing certain aspects until later stages of the project (UKHPR1000-005, 011, 014, 017, 043, 045 and 050).

These points reflect that GDA is just the first step in a process of ongoing regulation.

We regulate through design, construction, operation and decommissioning phases. We only cease regulatory control when the environmental permit is surrendered. Throughout these phases, the relevant information is changing and developing all the time. Managing this, to ensure all the necessary requirements are fulfilled at the appropriate time, is part of our normal regulatory business. Given the timescales associated with the development, operation and decommissioning of a nuclear reactor, it is reasonable that not all the detail for all phases is defined at the first stage. This is because government policy, regulatory requirements, technology and operational experience are all likely to change over these timescales. Decisions made at the wrong time may lead to making an ill-informed decision. It is also likely that the designer and operator will be different organisations and decisions made by the designer should enable operator decisions where appropriate and not constrain unnecessarily a future operator.

Generic design assessment

In GDA we start by assessing the aspects of the design that are likely to be identical irrespective of where the reactor unit is deployed, or how many units are deployed. For example, this early assessment considers the features of the design that generate, contain, minimise and treat radioactive waste. From this we can identify the expected waste streams and ensure we have disposal routes available for them in the UK and be confident that the amount of waste to be disposed of is as low as reasonably achievable. At this stage, we are assessing information provided by the reactor designer.

The operator is likely to be a separate organisation and will need to make their own decisions on how the reactor is operated (within the bounds of the designer’s limits and conditions of operations, the BAT case and safety case). For this reason, there are many decisions that are the responsibility of an operator that have not been made when we carry out the GDA, because the operator is not part of the GDA process. Where this is the case, we can make some assessment based on conservative estimates.

An example of an unresolved operator decision is the concern raised in response UKHPR1000-011, which related to a lack of information in GDA on management of the supply chain. It is for an operator to decide what to purchase from the supply chain, as a result some pieces of equipment are defined in GDA based on what they need to achieve rather than a specific piece of equipment, such as emergency diesel generators. This allows a future operator commercial freedom to choose the equipment to fulfil the specified requirements. How a future operator maintains control of their supply chain to ensure

requirements are fulfilled and quality assured is assessed as part of the site-specific permitting process and ongoing regulation.

Other information that is not available at GDA relates to the characteristics of any proposed site. If we do not have the appropriate information at the required level of detail in GDA we cannot make a valid assessment. Where this is the case, we defer assessment until the required information is available. Examples of this are:

- the impact of cooling water on aquatic organisms, which requires complex modelling based on specific site parameters
- the impact of flooding (as raised in UKHPR1000-045), which requires detailed site topography and building layout in addition to information on local weather and tidal flows

Two respondents (UKHPR1000-006 and 039) raised a concern that we were assessing a new ‘first of a kind’ design and were concerned that this meant that there was insufficient supporting evidence to assess.

The UK HPR1000 is a new reactor design for the UK and the first units in China are only just starting construction and operation, therefore there is no HPR1000 specific data available. However, the design is not new, it is a type of pressurised water reactor (PWR), a reactor design which has been in operation since the 1970s. The UK HPR1000 has evolved from known predecessor PWR designs, for which relevant data and operational information are available. The Requesting Party provided us with a document detailing the history of the development from the preceding designs, so we are aware of systems to which changes have been made.

Permit application

It is the future operator who will apply for environmental permits to construct and operate a reactor (or multiple reactors) at a specific site. At this point we expect all the necessary information to be provided to allow us to carry out a full assessment of operational decisions and environmental impacts for permit determination. An applicant will have to demonstrate that they can comply with an environmental permit and how they will do so. If we have any concerns, we can add extra permit conditions. Where an applicant has completed a GDA, this will include a demonstration of closing out GDA Assessment Findings.

Operation

After an operator is granted the relevant environmental permits we continue regulatory activities. A permit will contain multiple conditions which an operator must comply with. To ensure the conditions are complied with we carry out regular inspections of a site. We also ensure an operator is maintaining BAT and implementing improvements through regular reviews of their BAT case and operational practices and providing advice where necessary. Should we find evidence of non-compliance we have a range of enforcement options up to and including prosecution.

Two respondents (UKHPR1000-029 and 047) noted that there was no mention of powers of enforcement in the GDA documentation and there appeared to be an expectation in the responses that we apply enforcement during GDA.

GDA is advice to the RP under Section 37 of the Environment Act 1995. It is a voluntary process and therefore we do not use powers of enforcement in GDA. It is only once a permit is granted that powers of enforcement apply. However, we do assess all information provided to the same standards for GDA as we would for permitting, where relevant. Where we find concerns, we advise the designer on regulatory expectations in line with the current law and standards. Where there are outstanding matters relating to design that require operator decision or site-specific information, we use Assessment Findings to ensure these matters are followed through to resolution in later phases of the project.

One respondent (UKHPR1000-048) raised a concern over operator data tampering and noted we should have independent monitoring and data verification.

We do carry out independent monitoring to verify that the data submitted to demonstrate permit compliance is valid. We do this as part of our ongoing regulation using site inspections during operation. In GDA, we assess the sampling and monitoring systems to ensure that the design has the capability to allow us (or our nominated contractor) to obtain duplicate samples to be collected in tamper proof systems.

More information on the sample systems can be found in our sampling and monitoring assessment report – AR06 (Environment Agency, 2022f).

Decommissioning

Due to the period of construction and the long operational life of a nuclear reactor, there are some decisions that are not required to be made until well into the period of operation, for example, decommissioning. One respondent (UKHPR1000-014) noted that we had not carried out a full assessment of decommissioning and that we could not do so at GDA.

We agree. Clearly, decommissioning will be occurring far into the future, and we recognise that we cannot undertake a full assessment as part of GDA and we do not claim to do so. At GDA we start the process of planning for decommissioning by asking the designer to consider decommissioning at the earliest stage possible. This allows us to identify all likely waste streams, estimate quantities and check that all waste will be disposable. While the designer can facilitate decommissioning by considering safe dismantling and waste management as part of the design process, how decommissioning will be carried out in the future is a decision for a future operator, subject to our regulatory requirements under environmental permits.

Environment Agency role

Two respondents (UKHPR1000-015 and 018) questioned the Environment Agency’s role in such a large development. One suggested we contradict our corporate mission

statement (UKHPR1000-018) and one suggested we should challenge government policy on nuclear (UKHPR1000-015).

We do provide advice to government during policy development to help ensure that there is an appropriate consideration of environmental protection and the ability to carry out positive environmental regulation in national policies and strategies. However, once policy decisions have been made our role becomes one of regulation to protect people and the environment.

We work to ensure best practices are used throughout the life cycle of any project and that there is compliance with relevant legislation. In doing this, we must regulate in line with relevant legislation and government guidance. For example:

- the statutory principles of good regulation (Part 2 (21) on page 12 of the Legislative and Regulatory Reform Act, 2006, Chapter 51)
- the regulators' code (Regulators' Code - GOV.UK)
- the growth duty (Growth duty - GOV.UK)

As a result, we do not have the ability to stop any development because it is large, unpopular to some or a specific type of development (for example, nuclear). We must regulate (or provide advice to other decision makers) based on evidence, environmental impacts and the relevant legislation.

A7.4 Responses outside of our regulatory responsibilities

Where the points raised by individuals and organisation lie outside our regulatory responsibilities, we have passed a copy of the consultation response to the appropriate organisation for them to consider the points made. Please note that the Environment Agency, in line with normal regulatory process, has chosen to consult and respond to public comments in this matter. Other organisations involved have also chosen to follow their normal public interaction processes, which may not include consultation. Responses received that are relevant to organisations other than the Environment Agency have had all personal data removed before being passed on, due to data protection requirements. Therefore, the receiving organisations will not be able to reply to individual responses.

Below, we briefly summarise comments that fall into this category and indicate to which organisation we have passed copies of the consultation response.

In some cases, consultation responses are partially within our responsibility and partially within that of other organisations. In these cases, we have also responded elsewhere within this document.

A7.4.1 Energy policy or a preference for other technologies

Some respondents UKHPR1000-009, UKHPR1000-015, UKHPR1000-034, and UKHPR1000-040 cited preferences for alternative energy sources. For example, renewables for the production of electricity. Respondent UKHPR1000-050 also raised issues about technology choice. Two respondents UKHPR1000-028 and UKHPR1000-048 cited a preference for particular nuclear technologies to be chosen, other than UK HPR1000.

Choice of technology is not within our remit, nor is energy policy as detailed below. The government asked the regulators (the Environment Agency and ONR) to consider 'pre-licensing/authorisation assessments' of new nuclear power stations. In response, the regulators developed GDA, which allows us to assess the safety, security and environment protection aspects of new reactor designs at a generic level, before receiving an application to build a particular nuclear power station design at a specific location. Consideration of energy sources other than nuclear power is beyond the scope of GDA and a matter of government policy.

Energy policy in the UK is set by the Department for Business, Energy and Industrial Strategy (BEIS). Policy goals include broad decarbonisation, delivering low cost energy and clean growth. 60% of UK electricity is from low carbon generation; 16% of all UK electricity is currently from nuclear power.

The recent energy white paper published in December 2020 ‘Powering our Net Zero Future’ (BEIS, 2020) set out the role of nuclear as an important source of clean, reliable electricity. It also confirmed the commitment to take at least one further large gigawatt (GWe) plant to final investment decision. Government has developed an enabling policy framework for nuclear technologies and encourages the market to identify and bring forward cost effective technologies in its energy policy. The energy white paper also made a commitment to review and update the existing energy National Policy Statements to ensure that the planning policy framework can provide the investment required to build the infrastructure needed for the transition to net zero.

The energy white paper followed the Prime Minister’s 10-point plan for a Green Industrial Revolution in November 2020, with nuclear having a crucial role to play in the UK meeting net zero targets. Point 3 of the 10-point plan covers advancing nuclear as a clean energy source, with plans for new and advanced nuclear technologies (small modular reactors (SMRs) and advanced modular reactors (AMRs)) as part of our low carbon energy mix. There are target milestones for the first nuclear power stations using SMRs to be built in the UK by the early 2030s, alongside an (AMR demonstrator plant. In May 2021, government announced the opening of generic design assessment for applications for GDA of advanced nuclear technologies.

A7.4.2 Geopolitics

Several consultation responses raised concerns regarding the potential involvement of other nations in UK nuclear infrastructure. These responses were from UKHPR1000-006,

UKHPR1000-016, UKHPR1000-020, UKHPR1000-021, UKHPR1000-024, UKHPR1000-026, UKHPR1000-034, UKHPR1000-036, UKHPR1000-037 UKHPR1000-047, UKHPR1000-048 and UKHPR1000-051.

In addition, UKHPR1000-015 referred to the role of the Environment Agency in supporting government policy where it is seeking to secure overseas investment. Our role is distinct from government policy set by BEIS is covered in the previous section.

We are an independent regulator and our role is to assess the environment protection and waste management aspects of the reactor designs that enter into GDA. BEIS will only request the regulators to carry out a GDA for a reactor design if all criteria are satisfied based on a rigorous due diligence exercise it performs. The due diligence is carried out to provide assurances about the viability of the project, the design and the RP organisation. The due diligence reviews the technical maturity of the design, and the availability of funding throughout a GDA, which requires a serious commitment to be made over several years in resources and funding. The programme plans, finance and resourcing for the RP are examined as part of the due diligence process. BEIS also reviews the RP in terms of its capability and supporting infrastructure, processes and people, to assess the ability of the RP to provide a reactor design in an UK regulatory environment. BEIS considers these matters before a design is allowed to enter GDA. BEIS also gives due consideration to other matters such as national security in carrying out due diligence before allowing a reactor design to enter GDA.

A7.4.3 Economics

UKHPR1000-018 response referred to the funding needs for decommissioning and waste management.

There is a requirement for a future operator to put in place a funded decommissioning and waste management plan (DECC, 2011d) for a proposed new nuclear power station. This plan is to ensure that there is sufficient funds for decommissioning and waste disposal at the end of a new nuclear power station’s generating life.

We require a decommissioning strategy and plan to be developed at a very early stage during GDA to ensure that the design is optimised and decommissioning waste is minimised. We also require sustainability considerations to be taken into account as it is our job to protect people and the environment, while ensuring environmental and socio-economic benefit both now and into the future.

We engage early to ensure that the design of the power station incorporates best available techniques (BAT) to facilitate decommissioning and to minimise decommissioning waste. This is to minimise the impacts on people and the environment of decommissioning operations and the management of decommissioning wastes. Our engagement is also to influence and ensure materials are chosen to minimise the potential for activation and contamination during operation. There is also a requirement for the reactor designer to adopt the principles of the waste management hierarchy to avoid and minimise waste production.

Respondent UKHPR1000-030 raised issues around the economics of nuclear power when compared with other technologies. Technology choice is discussed in section A7.4.1.

Economic considerations are matters for government and, as detailed earlier in section A7.4.2, BEIS will carry out due diligence and other forms of checks and balance assessments to ensure the suitability of organisations entering into GDA, and to ensure that adequate funding and plans are in place for waste and decommissioning.

Government policy on new nuclear power stations and the role of the private sector and regulators is set out in the energy white paper published in December 2020 ‘Powering our Net Zero Future’ (BEIS, 2020). This confirms nuclear power as an important source of clean, reliable electricity. It also confirmed the commitment to take at least one further large GWe plant to final investment decision. Responses to the consultation on the Regulated Asset Base (RAB) model for private investment into large nuclear power stations were also published. These responses indicate that the RAB model remains credible for funding large nuclear projects. Point 3 of the Prime Minister’s 10-point plan covers plans for new and advanced nuclear technologies as part of our low carbon energy mix, with up to £40 million investment from government in support of developing regulatory frameworks and the supply chain.

A7.4.4 Availability of a geological disposal facility (GDF)

A number of responses were received regarding the availability of a GDF and the subsequent need for and duration of waste storage on site. These include response UKHPR1000-014 that raised issues around the timescale for availability of a GDF as well as points about plans for long-term radioactive waste management and how these are assessed. Respondents UKHPR1000-021, UKHPR1000-026, and UKHPR1000-027 raised issues on waste storage and disposal, as did UKHPR1000-041. These issues are considered in more detail in this document in A7.2.4 and our assessment report on radioactive waste and spent fuel management (Environment Agency, 2022e). Other respondents including UKHPR1000-008, UKHPR1000-010, UKHPR1000-011, UKHPR1000-015 and UKHPR1000-021 raised issues around on-site storage of higher activity radioactive waste and spent fuel, and availability of a GDF in their responses, as did respondent UKHPR1000-032. Lack of availability of a GDF was also raised by UKHPR1000-030, while respondent UKHPR1000-031 noted the technical issues of radioactive waste management and disposal were well understood, and referred to concerns being political rather than technical. Respondent UKHPR1000-038 raised the issue about availability of a GDF as well as concern about long lived radionuclides in the waste. UKHPR1000-043 raised interim storage of ILW and lack of availability of a GDF as a concern.

The need for a GDF to be developed for disposal of radioactive wastes is well established and will be required whether or not new nuclear power stations are built. Government’s policy for securing this facility is set out in the ‘Implementing Geological Disposal’ white paper (BEIS, 2018). BEIS is responsible for government policy on radioactive wastes and

it has given the responsibility for implementing a GDF to Radioactive Waste Management (RWM), a wholly owned subsidiary of the Nuclear Decommissioning Authority (NDA).

Plans for implementation of a permanent solution for the UK's higher activity radioactive waste are set out in RWM guidance (RWM, 2020). A GDF is internationally recognised as the safest long term solution for this type of waste. Currently discussions are happening with communities around England and Wales. Construction will only start when a suitable site has been identified, all the necessary consents and permits have been obtained and the host community has indicated its willingness to host the facility through a test of public support. For planning purposes we assume that a GDF will be available to receive the first waste in the 2040s, which is consistent with the RWM schedule.

The Environment Agency and ONR are responsible for regulating radioactive waste and work together to scrutinise plans from RWM as government has asked RWM to plan for and build a GDF. The Environment Agency publishes its findings on the scrutiny of RWM's work for geological disposal (Environment Agency, 2020a). As regulators for these wastes, we are working together with ONR to make sure that any future GDF will meet the high standards for environmental protection, safety and security that the public expects.

We have established agreements with RWM, to provide regulatory advice and to scrutinise its work developing a GDF. We are engaging with RWM early, before regulation starts, so that when a site is identified RWM already clearly understands what it needs to do as part of the regulatory process. We also liaise regularly with RWM to make sure that it gives the right advice to waste producers about packaging radioactive waste for future disposal at a GDF.

A7.4.5 Safety

Response UKHPR1000-014 raised concerns about the safety and security of a hybrid cooling system. Safety and security are within the remit of the Office for Nuclear Regulation and this response has been shared with ONR for consideration. The same respondent also raised concerns about major accidents and COMAH Regulations. We and ONR are the joint competent authority for the COMAH Regulations. The consequences of major accidents to the environment were considered earlier in this report in section 16.

UKHPR1000-031 referred to concerns about inherent safety and whether this has been considered in detail. This response has been passed to ONR for consideration.

UKHPR1000-006 raised the issue of safety for first of a kind (FOAK) designs. This issue has been passed to ONR for consideration.

Respondent UKHPR1000-012 raised issues about climate change, weather (also UKHPR1000-008) and geographical changes to the site and building over periods of more than a century. They also raised concerns about sea defences and flooding. These issues are site-specific, but also fall within external hazards for ONR. UKHPR1000-018 also raised flooding as a concern. There will be further consideration of flooding during site-specific applications, and further opportunities to engage on these topics.

Control and Instrumentation issues were raised by UKHPR1000-025, in particular in regard to substantiation. This has been referred to ONR as it regulates safety matters.

One respondent UKHPR1000-047 raised operational procedures and systems, and the potential for failure of alarm systems. This has been referred to ONR as the safety regulator for consideration.

A7.4.6 Accidents

Respondent UKHPR1000-026 raised accident scenarios. Emergency planning in the event of an unforeseen incident was raised by respondent UKHPR1000-015, as well as consideration of events beyond normal operating experience. Respondent UKHPR1000-050 raised the issue of accidents creating further discharges, and also long-term accumulation of discharges in the environment. Discharges are considered earlier in this document (section 8).

We consider normal operations, including the potential for some abnormal events to occur during the operating life of the reactor, typically over a 60-year period. Accidents are within ONR's regulatory remit.

These responses have been shared with ONR for its consideration.

A7.4.7 Health

The UK Health Security Agency (previously Public Health England (PHE)) is advisor on health matters to government and other bodies in the UK. UKHPR1000-007 from the Low Level Radiation Campaign (LLRC) made reference to comments made in a meeting between the NGOs and PHE. The meeting took place in February and the respondent noted that PHE said "not all organisations use 1 in a million health detriments as a regulatory criterion for assessing acceptable risk", and that "work is going on about tolerability". The response from UKHPR1000-007 asked about the dose risk criteria that will be applied for HPR1000, and how any discrepancies in health detriment estimates will be resolved. This comment was discussed earlier in this appendix, section A7.2.4.

UKHPR1000-013 from the LLRC in its response refers to its paper 'Radiation and reason: The impact of science on a culture of confusion: http://www.llrc.org/PreliminaryREPORTforCwCUK26062020.pdf'.

This is in regard to the International Commission on Radiological Protection (ICRP) methods for assessing radiation risk, and the concern raised is for dose impact from alpha radiation. UKHPR1000-014 from BANNG raises potential limitations for the ICRP model in assessing radiation risk. UKHPR1000-015 from Together Against Sizewell C endorses the comments of LLRC in respect of gaseous and liquid discharges and refers to the same report.

We asked PHE for advice on the issues raised in regard to the ICRP methodology and childhood cancer. PHE advised that the report does not provide any additional evidence

that would require changes to our radiological dose assessment methodology, which is based on the recommendations of the ICRP. We have considered the advice from PHE and the information provided in consultation and conclude that it remains appropriate for us to use the ICRP framework as the basis for our radiological impact assessments.

Table A7-3 Points raised by individuals and organisations that fall outside or partially outside our regulatory responsibilities and have been passed on to other organisations for consideration

Response reference	Summary of point raised outside our responsibilities	Responsible organisations provided with a copy	Also addressed in section
UKHPR1000-009,15,28,34,40,48,50	Technology choice, energy policy	Department for Business, Energy and Industrial Strategy (BEIS)	A.7.4.1
UKHPR1000-06,15,16,20,21,24, 26,34,36,37,47,48,51	Geopolitics	BEIS	A7.4.2
UKHPR1000-018, 030	Economics	BEIS	A7.4.3
UKHPR1000-008,10,11,14,15,21,26,27,30, 31,32,38,41,43	GDF availability	BEIS, Radioactive Waste Management (RWM)	A7.2.4, A7.4.4 and AR05
UKHPR1000-006,012,014,18,25,31,47	Safety	Office for Nuclear Regulation (ONR)	A7.4.5
UKHPR1000-015,26,50	Accidents	ONR	Section 16, A7.2.4, A7.4.6 and AR08
UKHPR1000-007,13,14,15	Health	UK Health and Security Agency (previously Public Health England (PHE))	A7.2.4, A7.4.7 and AR07

Appendix 8 Summary of operational wastes from the UK HPR1000

The following information is taken from the RP's Pre-Construction Environmental Report, chapter 4 (GNSL, 2021b).

Waste type	Main radionuclides	Description	Source	Annual arisings (unless stated)	Average activity beta/gamma (GBq/tonne)	Waste management route
ILW spent resins	caesium-134 and 137, cobalt-58 and 60, nickel-63, iron-59 and silver-110m	Cross-linked polystyrene spheres	Arising from demineraliser in the FPCTS, CVCS, CSTS, LWTS and SGBS if steam generator fails	1.9m^3	5.8 x10^2	Dry within robust shielded containers and then dispose to a GDF
LLW resins	silver-110m, antinomy-124 and 125 and iron-59	Cross-linked polystyrene spheres	From 2 demineralisers in the SGBS	9.7m^3	2.35 x10^{-2}	Package within 210L drum and then transfer off site for incineration
Concentrates	cobalt-60, iron-55, nickel-63 and silver-110m	Evaporator concentrates contaminated with activated and fission products	Arise from LWTS evaporator	LLW 1.47m^3	4.37	Grout in a 210L drum and then dispose to the LLW repository
Concentrates	cobalt-60, iron-55, nickel-63 and silver-110m	Evaporator concentrates contaminated with activated and fission products	Arise from LWTS evaporator	ILW 0.73m^3	22.8	Grout in a 210L drum, decay store and then dispose to the LLW repository

Waste type	Main radionuclides	Description	Source	Annual arisings (unless stated)	Average activity beta/gamma (GBq/tonne)	Waste management route
Sludges	cobalt-60, nickel-63, iron-55 and silver 110m (only for ILW sludges)	Contamination with activated and fission products	Arise from tanks and sumps in the within the auxiliary circuit	LLW 0.05m^3	4.18	Grout in a 210L drum and dispose of to the LLW repository
Sludges	cobalt-60, nickel-63, iron-55 and silver 110m (only for ILW sludges)	Contamination with activated and fission products	Arise from tanks and sumps in the within the auxiliary circuit	ILW 0.05m^3	59.6	Grout in a 210L drum, decay store and then dispose of to the LLW repository
Spent filter cartridges	cobalt-58, chromium-51, iron-55 and silver-110m	Stainless steel support, glass fibres and organics	Arise from the CVCS, FPCTS, CSTS, LWTS, SGBS and VDS	LLW 0.65m^3	6.18 x10^{-3}	Packaged in a 210L drum and super compacted off site
Spent filter cartridges	cobalt-58, chromium-51, iron-55 and silver-110m	Stainless steel support, glass fibres and organics	Arise from the CVCS, FPCTS, CSTS, LWTS, SGBS and VDS	ILW 1.14m^3	9.14 x10^2	Grout in a 3m^{3}box and dispose of to a GDF
Dry active waste (Combustible)	cobalt-58 and 60, niobium-95 and iron-55	Paper, plastic, cloth	Operations and maintenance activities	LLW 126.81m^3	2.77	Package in 210L drum and incinerate off site

Waste type	Main radionuclides	Description	Source	Annual arisings (unless stated)	Average activity beta/gamma (GBq/tonne)	Waste management route
Dry active waste (Combustible)	cobalt-58 and 60, niobium-95 and iron-55	Paper, plastic, cloth	Operations and maintenance activities	ILW 17.94m^3	16.2	Package in 210L drum, decay store and then dispose of to the LLW repository
Dry active waste (Metals)	cobalt-58 and 60, niobium-95, iron-55	Metals	Operations and maintenance	LLW 10.44m^3	2.77	Package in a metal box and sent off site for melting
Dry active waste (Metals)	cobalt-58 and 60, niobium-95, iron-55	Metals	Operations and maintenance	ILW 1.56m^3	16.2	Package in 210L drum, decay store, transfer in metal box off site for melting
Dry active waste (compactable)	cobalt-58 and 60, niobium-95 and iron-55	Cable, plastics	Operations and maintenance	LLW 14.79m^3	2.77	Package in 210L drum and then send off site for compaction
Dry active waste (compactable)	cobalt-58 and 60, niobium-95 and iron-55	Cable, plastics	Operations and maintenance	ILW 2.21m^3	16.2	Package in 210L drum, decay store, then send off site for compaction
Dry active waste (non-compactable/	cobalt-58 and 60, niobium-95, iron-55	Concrete and glass	Operations and maintenance	LLW 4.35m^3	2.77	Packaged in iso-freight for disposal to LLW repository

Waste type	Main radionuclides	Description	Source	Annual arisings (unless stated)	Average activity beta/gamma (GBq/tonne)	Waste management route
non-combustible)						
Dry active waste (non-compactable/ non-combustible)	cobalt-58 and 60, niobium-95, iron-55	Concrete and glass	Operations and maintenance	ILW 0.65m3	16.2	Packaged in iso-freight for disposal to LLW repository
Oil	cobalt-58 and 60, niobium-95, nickel-63, iron-55	Lubricating oil	Maintenance of hydraulic equipment	VLLW/LLW 0.13m^3	2.12 x10^{-4}	Packaged in a 210L drum and incinerate off site
Organic solvent	cobalt-60, iron-55 and nickel-63	Organic solvents	Normal operations for example removing contamination from reactor bolts	VLLW/LLW 0.2m^3	1.38 x10^{-4}	Packaged in a 210L drum and incinerate off site
Ventilation filter cartridges	cobalt-60, iron-55, nickel-63	Stainless steel support with glass fibres	HVAC systems	LLW 29.7m^3	1.62 x10^{-2}	Package within a bag and sent off site for super-compaction and subsequent disposal at the LLW repository
RCCAs	silver-109m, cadmium -109, chromium-51, iron-55	Control cluster assemblies	Arise from the reactor core	HLW	Black 2.98 x10^8 and Grey 1.53 x10^8	Package in disposal canister with spent fuel and co-disposed with spent fuel
SCCAs	chromium-51, iron-55, antimony-122 and 124,	Thimble plug, primary and	Arise from the reactor core	HLW	7.73 x10^7 (TPAs), 5.4 x10^8 (PNSAs)	Package in disposal canister with spent fuel and co-disposed with spent fuel

Waste type	Main radionuclides	Description	Source	Annual arisings (unless stated)	Average activity beta/gamma (GBq/tonne)	Waste management route
		secondary neutron sources			and 8.79 x10^{8} (SNSA)	
ICIAs	cobalt-58, chromium-51, iron-55, cobalt-60	Instruments used to core properties such as temperature and neutron flux	Arise from reactor core	ILW 0.01m^{3}	4.0 x10^{3}	Packaged in robust shielded container and disposed of to the GDF
ICIAs	cobalt-58, chromium-51, iron-55, cobalt-60	Instruments used to core properties such as temperature and neutron flux	Arise from reactor core	HLW 0.13m^{3}	2.96 x10^{7}	Packaged in a robust shielded container, decay stored and disposed of to the GDF

Appendix 9 Summary of decommissioning wastes

Waste type	Waste classification	Waste volume (m^3)	Waste container	Total waste package volume (m^3)
RPV	ILW	50	4m box	374
RVI	ILW	18	$3m^3$ box	74
Concrete	ILW	150	4m box	352
Spent resins	ILW	40	500L robust shielded drum	110.5
Spent filter cartridges	ILW	1.4	$3m^3$ box	7.4
Other equipment and concrete wastes	VLLW/LLW	12021	Half-height isofreight container	28196

Appendix 10 Summary of RWM's ILW assessment findings to be addressed during future disposability assessment interactions

The main findings RWM raised within its assessment for the disposal of ILW wastes are for:

- the post closure phase, the RVI waste packages challenged the heat output criteria at the time of disposal vault backfilling
- the post closure phase, the RVI have a high specific activity for carbon-14 and, although this is similar to other waste streams from equivalent systems, further consideration should be given in the future to the carbon-14 inventory and the release rate in future disposability assessments
- ICIA waste packages, the radiogenic heat output of the maximum package, with a conservatively assumed decay period of 10 years, may exceed the target value of 3W at the time of backfilling of the disposal vault

In addition to the above main findings, RWM has also raised a number of packaging issues and general issues:

RPV/RVI

- The waste loading of the RVI within a $3m^3$ box are near the mass limits for the package, and the package efficiency may not be achievable.
- The high internal dose rates within the RVI waste packages and the radiogenic heating may have implications for the long-term integrity of the grouted waste form.
- For the RVI and the RPV, the degree of heterogeneity due to the variation in irradiated regions and the ability for the grout to infiltrate the waste.

Concentrates/sludges

- It will be necessary to develop encapsulant formulations and demonstrate that the waste has been rendered into a passive form.

Decommissioning concrete

- Accounting for the presence of stainless steel reinforcement within the decommissioning ILW concrete.
- For concrete waste the dose rates are significantly below the limits for transport and therefore there is potential for optimisation of the packages.

Spent filter cartridges

- For cartridge filters in a $3m^3$ box, detailed packaging solutions are required to ensure that, for example, the filters are encapsulated and the voidage is minimised. The voidage within packages needs to be controlled to ensure that the barrier within the GDF performs as expected.

ICIAs

- For the ICIA wastes, the RP has proposed a new container, based on a robust shielded container with 150mm stainless steel shielding within it. RWM's assessment highlights that this container will need some development and a future operator will need to provide evidence to support that the container will perform as expected.

Non-encapsulated wastes

- For non-encapsulated wastes, such as the ion exchange resins and ICIAs, a future operator will need to demonstrate that free water can be removed from the wastes.
- There is the potential that the voidage within the package will need to be addressed in the future.

General issues

- In RWM's assessment of the ILW and the fuel, it highlights the lack of information with regard to the presence of toxic/hazardous materials, but in particular more comprehensive information and data, including the impurities in irradiated materials, hazardous substances and non-hazardous pollutants.
- During a number of the decommissioning operations, particulate matter will be produced from cutting operations and will need to be quantified and a disposal option developed.

Appendix 11 Summary of RWM's spent fuel/RCCAs/SCCAs assessment findings to be addressed in future disposability assessments

The main findings that RWM raised within its assessment for the disposal of spent fuel/RCCAs/SCCAs wastes are:

Main issues

- For criticality compliance RWM will need to take credit for burn up, so that compliance with the post closure criticality case can be made. A future operator will need to ensure that its records will contain the relevant information to allow RWM to do this. RWM has not assessed the intentional inclusion of neutron sources before.
- Fuel management options will need to be assessed to allow for disposal of the UK HPR1000 spent fuel within the current assumed closure date for a GDF, to comply with the buffer temperature requirements.

Packaging specific and general issues

- Steps will need to be taken to ensure that water carry over is minimised during the drying process for the spent fuel assemblies, to minimise the risk of corrosion and gas build up within the package.
- Ensure that the requirements for the disposal of spent fuel from the UK HPR1000 are considered when designing the disposal container.
- Limited data have been provided with regard to hazardous materials and non-hazardous pollutants, therefore a more comprehensive inventory will be required for future disposability assessments.
- Information with regard to the amount of gadolinia present within the spent fuel assemblies will need to be provided and recorded within the waste packages records. Further assessment of this area will be carried out as part of the future disposability assessment.

Appendix 12 Resolution of the potential GDA Issues identified at consultation

At consultation, we highlighted 6 potential GDA Issues. The RP has since submitted the additional information required to close out the 4 related Regulatory Observations (RO-UKHPR1000-036, RO-UKHPR1000-037, RO-UKHPR1000-041 and RO-UKHPR1000-044). In addition, information was received from the nominated fuel supplier on the storage conditions required for spent fuel and ONR has not raised any ALARP issues that could result in a re-evaluation of BAT. Further information relating to the closure for each potential GDA Issue is summarised below.

Potential GDA Issue 1: The Environment Agency and ONR have identified shortfalls across UK HPR1000 safety case documentation in identifying and using operating experience (OPEX). We expect relevant OPEX to be identified and considered to support the development of environmental protection functionality in the design, consistent with applying best available techniques (BAT).

We highlighted shortcomings in the RP's operating experience (OPEX) arrangements during our stage 2 assessment work, and noted this as a potential GDA Issue at the time of our public consultation. Regulatory Observation (RO) RO-UKHPR1000-0044 was issued to identify these shortcomings and seek the RP's commitment to improvement. The RP subsequently established a resolution plan entailing modifying OPEX procedures, training, and submitting a sample of new and updated safety case documentation to demonstrate the application of their revised, strengthened arrangements. We have confirmed, by assessing the revised procedures and inspecting arrangements and working jointly with ONR, that the RP has introduced appropriate changes to its OPEX procedures and training, and that these have been implemented effectively. Consequently, we consider that the potential GDA Issue on OPEX identified in our consultation document is now closed.

Potential GDA Issue 2: The RP has not yet provided a demonstration that selected options are optimised with respect to environmental protection and safety. We require the RP to demonstrate that it has considered environmental aspects, alongside safety aspects, in order to achieve a design optimised for both.

At the time of writing our consultation document (January 2021), our preliminary conclusions were that the RP has demonstrated the UK HPR1000 to be consistent with our expectations on BAT, in so far as this has been demonstrated and to a level in line with our expectations for GDA. However, we could not make our final conclusion as ALARP (as low as reasonably practicable) aspects of the design were yet to be fully demonstrated to, and accepted by, ONR, and a few relevant ROs remained open. We concluded that BAT was adequately addressed in the RP's design development processes and therefore anticipated that any design changes that may result from ongoing ALARP considerations would be appropriately assessed in terms of BAT. However, pending appropriate outcomes, we raised a potential GDA Issue that required the RP to

demonstrate that appropriate consideration has been given to both environmental and safety aspects, to achieve an optimised design. ONR had raised a number of ROs for plant systems where BAT is also relevant (such as radioactive waste management systems). These ROs have now been closed to the regulators' satisfaction. Closure has not resulted in any significant design changes or impacts on the claims, arguments and evidence that the RP has made in its demonstration of BAT document. We are therefore content that the RP has demonstrated that the UK HPR1000 design is consistent with our expectations on BAT and suitably optimised in line with our expectations for GDA.

Potential GDA Issue 3: The RP has provided environmental justification for the choice of high efficiency particulate air filter design. However, further justification must be provided to demonstrate how best available techniques is applied.

Going into our public consultation we cited a potential GDA Issue that required the RP to demonstrate how BAT is applied for its choice of HEPA filter design. Based on the submissions the RP made, we judged there were potential shortfalls associated with the demonstration that the optioneering study and justification of the choice of HEPA filter comprehensively considers the minimisation of fugitive discharges, energy use and the production and disposal of radioactive waste. We submitted an RO (RO-UKHPR1000-036) and raised our concerns noted in the potential GDA Issue 3.

The RP's response primarily consisted of revising its HEPA filter type optioneering report as committed to in its resolution plan. The evaluation of the choice of HEPA filter type included an improved assessment of the options against the safety, environmental, technical and economic criteria. The supporting OPEX was expanded from 5 to 25 years and the RP ensured that the relevant disciplines' suitably qualified and experienced person participated in the optioneering and decision-making workshop. The assessment of the environmental impact of fugitive discharges was expanded in the revised HEPA optioneering report to highlight that the aerosol dose accounts for only 0.1% of the total dose from gaseous discharges, indicating that fugitive discharges would be significantly less and therefore negligible. The negligible dose from fugitive discharges indicates that a small reduction in sealing performance for a filter choice will not be detrimental to the demonstration of BAT. The generation of waste from the 2 HEPA filter options was demonstrated to be the same, with some reasonable assumptions made where information was not readily available. The RP noted that the advantages of cylindrical filters for facilities with higher levels of radioactivity do not apply to a PWR with low levels of activity, which strengthened the demonstration of BAT. The RP submitted the information committed to in its resolution plan, which was sufficient to meet the intent of the RO. The RP has addressed the issues which led to the RO being raised, resulting in the potential GDA Issue being resolved.

Potential GDA Issue 4: The RP is required to provide information in relation to the long-term storage requirements for the spent fuel and to demonstrate that the conceptual design for spent fuel interim store (SFIS) will deliver these requirements.

We identified a potential GDA Issue in our report for public consultation requiring the RP to provide information with regards to the long-term storage requirements for the spent fuel

as well as information that the conceptual SFIS design will have the capability to meet these requirements. We raised this potential issue as at the time of consultation, as the RP had not provided any supporting information to demonstrate this.

The RP has provided us with information to demonstrate that the $M5_{Framatome}$ alloy cladding and structural components of the spent fuel assemblies (SFAs) are highly resistant to corrosion (GNSL, 2021z). In addition, the RP has also provided information from Framatome with regard to the fuel criteria needed to ensure long-term integrity of the fuel during dry interim storage.

ONR, as the lead regulator for the interim storage of SFAs, on site has also assessed this area. The storage of spent fuel on site is an area of mutual interest to both ONR and ourselves. We note that within ONR's assessment (ONR, 2021) of the long term storage the SFAs that they are not content that the RP has provided evidence of the criteria that will preclude embrittlement of the fuel cladding by hydrogen realignment. ONR have stated that they expect to see further refinement of the criteria and the evidence to substantiate this by a future operator of the UK HPR1000. As a result of this conclusion, ONR has undertaken an assessment to evaluate if there is sufficient flexibility within the generic design of the UK HPR1000 to accommodate any future changes to the fuel criteria. ONR has concluded that they are confident that there is a low risk of the fuel criteria not being able to be delivered by the current generic design of the UK HPR1000.

With the flexibility in the operation of the UK HPR1000 and that the design of the SFIS is at a conceptual level, we see no reason why the criteria for ensuring the integrity of the fuel cannot be delivered at the site specific stage.

We are content that the RP has addressed our concerns with regard to the potential GDA Issue we identified in our consultation assessment report and provided sufficient information for GDA. In our assessment report, we have noted that currently there is no OPEX to support the storage of SFAs over the 100-year time period. In addition, there have been no transfers of the SFAs from the interim storage canister to a disposal container internationally. Therefore, we have raised Assessment Finding 31 (see Appendix 2) as we see it as an important requirement for a future operator to continue to engage with other operators, who are further along the life cycle for the dry storage of spent fuel, to ensure that they capture any learning regarding storage of the fuel and its future transfer to a disposal container.

Potential GDA Issue 5: The RP is required to provide further substantiation of the proposed strategy for the management of in-core instrument assemblies (ICIAs) and if any changes to the strategy are decided, to assess the impact on the disposal of ICIA wastes.

We previously raised a potential GDA Issue requesting the RP to further substantiate its proposed strategy for the management of ICIAs after ONR raised RO-UKHPR1000-037. We also asked if any changes to the strategy were identified as a result of this RO and whether this would have any impact on the disposal of the ICIAs. The RP has assessed a number of potential alternative management strategies, as part of its optioneering assessment for the management of ICIAs, to ensure that the option chosen is indeed the

lead option. We are content that the information provided is sufficient to address the GDA Issue that we raised and provides sufficient information for GDA.

Potential GDA Issue 6: The RP is required to demonstrate that all higher activity waste (HAW) arisings from the UK HPR1000 will be disposable.

We raised a potential GDA Issue and also RO-UKHPR1000-0041 to ensure that the RP provided sufficient information with regard to the disposal of HAW arising from the UK HPR1000 within the timeframe of this GDA. The RP has now provided RWM's disposability assessment report, which covers all HAW arising from the operation and decommissioning of the UK HPR1000 and this has demonstrated that the wastes are likely to be disposable. In addition, the RP has provided additional information to summarise how a future operator will address the action points that RWM has raised within its disposability assessment report. These will be addressed as part of the ongoing letter of compliance (LoC) process that will cover the operational and decommissioning stages of the reactor's life cycle. We are content that the information the RP provided is sufficient for GDA and closure of the potential GDA Issue.

Would you like to find out more about us or your environment?

Then call us on

03708 506 506 (Monday to Friday, 8am to 6pm)

Email: enquiries@environment-agency.gov.uk

Or visit our website

www.gov.uk/environment-agency

incident hotline

0800 807060 **(24 hours)**

floodline

0345 988 1188 **(24 hours)**

Find out about call charges (https://www.gov.uk/call-charges)

Environment first

Are you viewing this onscreen? Please consider the environment and only print if absolutely necessary. If you are reading a paper copy, please don’t forget to reuse and recycle.