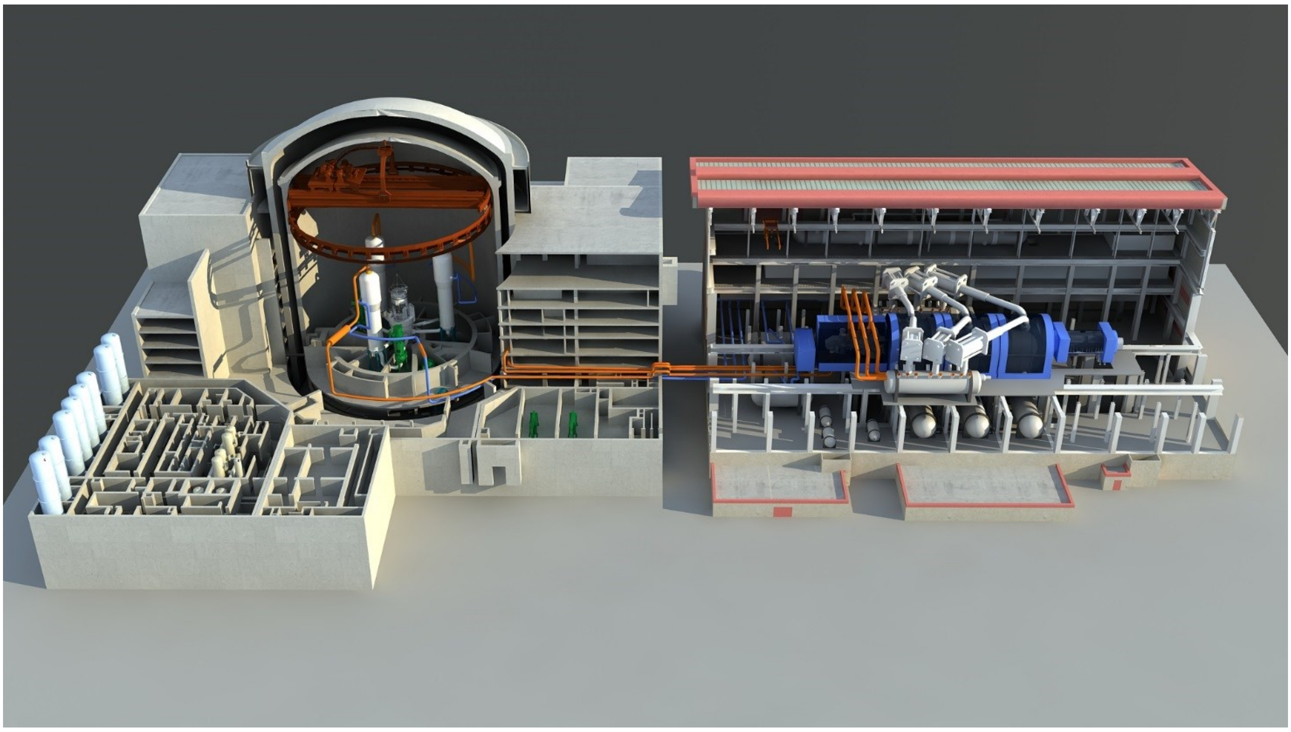

Generic design assessment of candidate nuclear power plant designs

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

Version 1 - 15 November 2018

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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.

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Published by:

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Bristol BS1 5AH
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Executive summary

This report sets out our findings following the initial stage of generic design assessment (GDA) for the UK HPR1000 nuclear power plant design. General Nuclear System Ltd (GNS) (the 'Requesting Party') submitted this design for GDA. GNS is a joint venture of the requesting parties, China General Nuclear Power Corporation (CGN), General Nuclear International (GNI) and Électricité de France (EDF).

GDA means that we assess if the environmental aspects of a design are acceptable at a generic level before site-specific applications are made. This allows us to get involved at the earliest stage, when we can have most influence, and it also reduces regulatory uncertainty for designers and potential operators.

We carry out our GDA in 2 stages.

In our **initial assessment,** we examine the Requesting Party's submission at an outline level. Our aim is to identify whether we need any further information, if there are any matters that are obviously unacceptable, or if any significant design modifications may be needed.

Detailed assessment is when we examine the submission in detail to come to a preliminary view on whether or not to issue:

- a Statement of Design Acceptability (SoDA)
- an interim Statement of Design Acceptability (iSoDA) with identified GDA Issues (issues that are significant but can be resolved)
- neither of these, because the design is unsuitable

We will only make our final decision after we have consulted the public and carefully considered the responses we receive.

This document outlines our findings from the initial assessment stage.

We regulate several aspects of the operation of nuclear power stations in England. Our GDA focuses mainly on matters relevant to the disposal of radioactive waste. This is for 2 reasons:

- 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, historically, been the area of regulation with the longest lead time for permitting new nuclear power stations.

However, we also address aspects of the design related to other areas of regulation we are responsible for, as far as is practicable, when considering a generic design.

The overall conclusions of our initial assessment for the UK HPR1000 nuclear power plant design are:

- The submission adequately addresses our information requirements (as set out in our Process and Information Document (P&ID) (Environment Agency, 2016)) for initial assessment. GNS has identified the outstanding information and has committed to providing this within a timescale that, subject to the quality of the information, should allow us to carry out detailed assessment and to maintain our overall target of completing a meaningful GDA in 4 years.
- At this stage, we have not identified any matters in the submission that are obviously unacceptable. We have not identified any significant design modifications that are likely to be needed.

These conclusions are based on our initial assessment of the information we have received so far. Once GNS has provided all the required information, we may still identify unacceptable matters or design modifications during our detailed assessment.

Contents

Executive summary **3**

1. Introduction **5**

1.1. Purpose of this document 5

1.2. About GDA 5

1.3. Regulation of nuclear power stations 6

2. The UK HPR1000 design **7**

2.1. Outline of design 7

2.2. Sources, processing and disposal of radioactive waste 7

2.3. Non-radioactive waste 8

3. The Environment Agency's GDA process for the UK HPR1000 ...... **9**

3.1. Process 9

3.2. Next steps 10

4. Initial assessment - detailed level **11**

4.1. General Nuclear System's management system 11

4.2. Generic site description and assessment of the impact of proposed radioactive discharges 13

5. Initial assessment - principle level **17**

5.1. Radioactive waste management arrangements 17

5.2. Quantification and assessment of radioactive waste disposals 22

5.3. Measurement of discharges and disposals of radioactive waste 23

5.4. Aspects related to other environmental regulations 24

6. Overall conclusions of our initial assessment **28**

6.1. Further information 28

7. References **29**

8. List of abbreviations **31**

Annexe 1- Documents considered during initial assessment **33**

Annexe 2 - Further information required for detailed assessment **34**

1. Introduction

1.1. Purpose of this document

This report sets out our findings following the initial stage of generic design assessment (GDA) for the UK HPR1000 nuclear power station design. General Nuclear System Ltd (GNS) (the 'Requesting Party') submitted this design for GDA.

GNS is a joint venture of the requesting parties, China General Nuclear Power Corporation (CGN), General Nuclear International (GNI) and Électricité de France (EDF). Further information can be found on the UK HPR1000 website.

1.2. About GDA

Our GDA process is described in our Process and Information Document (P&ID) (Environment Agency, 2016). GDA means that we assess if the environmental aspects of a design are acceptable, at a generic level, before site-specific applications are made. The Office for Nuclear Regulation (ONR) has introduced a similar process for assessing the safety and security aspects of a design. We are working closely with ONR to ensure an effective and efficient assessment process.

GDA allows us (the Environment Agency and ONR) as regulators to get involved with designers and potential operators at the earliest stage, when we can have most influence and where lessons can be learned that may apply to other designs or from other design assessments. GDA also reduces regulatory uncertainty for designers and potential operators, improving confidence and reducing risks for developers in future build programmes.

In line with the government's aim of reducing the burden of regulation on industry, we and ONR have:

- asked Requesting Parties to provide information about their designs as a single, integrated package of submissions, addressing the requirements of both regulators
- set up a Joint Programme Office (JPO) to administer the assessment process on behalf of both regulators as a 'one-stop shop'

We carry out GDA in 2 stages.

In our **initial assessment,** we examine the Requesting Party's submission at an outline level. Our aim is to identify whether we need any further information, if there are any matters that are obviously unacceptable, or if any significant design modifications may be needed.

Detailed assessment is when we examine the submission in detail to come to a preliminary view on whether or not to issue:

- a Statement of Design Acceptability (SoDA)
- an interim Statement of Design Acceptability (iSoDA) with identified GDA Issues (issues that are significant but can be resolved)
- neither of these, because the design is unsuitable

We will only make our final decision after we have consulted with the public and carefully considered the responses we receive.

This document is a statement of findings from our initial assessment.

Our GDA work is carried out under an agreement made with the Requesting Party under section 37 of The Environment Act 1995 (EA95). Following a request from government for us to carry out a GDA of the UK HPR1000, we began this work in January 2017 after signing our section 37 agreement.

We regulate several aspects of the operation of nuclear power stations in England, as set out in section 1.3 of this report. However, our GDA focuses mainly on matters relevant to the disposal of radioactive waste. This is for 2 reasons:

- 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, historically, been the area of regulation with the longest lead time for permitting new nuclear power stations.

We also address other areas of regulation we are responsible for, as far as is practicable, when considering a generic design. We do not address flood defence through this process due to its site-specific nature. But rather, we would assess any relevant flood defence issues during permitting.

In carrying out GDA, we take into account all relevant statutory, policy and regulatory matters and constraints, except where these can only be addressed on a site-specific basis. We also take our Radioactive Substances Regulation Environmental Principles (REPs) (Environment Agency, 2010a) into account throughout the process.

As part of the GDA process we use various mechanisms to interact with the requesting party, these are outlined below:

- A Regulatory Query (RQ) is used to request further information for clarification purposes
- A Regulatory Observation (RO) is used to indicate a potential regulatory shortfall and request additional work
- A Regulatory Issue (RI) is used to indicate a significant regulatory shortfall that requires additional work to resolve

1.3. Regulation of nuclear power stations

We regulate several aspects of the operation of nuclear power stations in England.

The disposal of radioactive waste requires a permit under The Environmental Permitting (England and Wales) Regulations 2016 (EPR16).

The discharge of aqueous effluents, such as from cooling or dewatering during construction, requires a permit under EPR16.

Some conventional plant, for example, combustion plant used as auxiliary boilers and emergency standby power supplies, and incinerators used to dispose of combustible waste, may need a permit under EPR16. Some combustion plant may also need a permit under The Greenhouse Gas Emissions Trading Scheme Regulations 2012 (as amended).

The disposal of waste by depositing it on or into land, including excavation materials from construction, and other waste operations may require a permit under EPR16.

The abstraction of water, for example, for cooling or process use, from inland waters or groundwater, except in some specific circumstances, requires a licence under The Water Resources Act 1991 (WRA91). Inland waters include rivers, ponds, estuaries and docks, among others.

The construction of new or enhanced flood defence structures, or modification of existing ones, requires a flood defence consent under EPR16.

The Environment Agency and the Health and Safety Executive together form the competent authority for The Control of Major Accident Hazards Regulations (COMAH) 2015. On-site storage of certain substances may fall under these regulations.

We also regulate the use of certain gases used mainly for cooling and air conditioning under The Fluorinated Greenhouse Gases Regulations 2015.

2. The UK HPR1000 design

This section provides a brief outline of the design and how waste will be created, processed and disposed of.

2.1. Outline of design

The UK HPR1000 design for GDA is a single, 3-loop pressurised water reactor (PWR) capable of generating 1,180 megawatts (MW) of electricity. In the reactor core, the uranium oxide fuel (enriched to up to 5% of uranium-235) 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 reactor.

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 HPR1000 operating yet, but there are 2 units under construction in China (Fangchenggang units 3 and 4).

The HPR1000 design is based on ‘Hualong’ technology and is an evolution of previous French and Chinese power station designs, including the French M310 design, the CPR1000 (14 units in operation) and the ACPR1000, with 4 units currently under construction (Yangjiang units 5 and 6 and Hongyanhe units 5 and 6).

2.2. Sources, processing and disposal of radioactive waste

Radioactive waste would 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). 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 carbon bed delay system. Gaseous activity 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 filtration, 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 at 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 a GDF is available. The design includes space for an interim spent fuel storage facility.

2.3. 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
- 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

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 scope of GDA, as they are best considered if or when site-specific proposals are made.

3. The Environment Agency's GDA process for the UK HPR1000

3.1. Process

The P&ID (Environment Agency, 2016) sets out in detail the process that we follow during GDA for any Requesting Party. This section details the steps we have taken during the initial stage of GDA for the UK HPR1000 design.

We established an agreement with GNS, under section 37 of EA95, to carry out and recover our costs for GDA of the UK HPR1000 design. This came into effect in January 2017. We set out, together with ONR, a timetable for this initial stage of the work (Environment Agency's initial assessment and ONR's 'Step 2')). This started with GNS submitting its Preliminary Safety Report (PSR) on 27 October 2017. The PSR includes information relating to safety, security and environmental matters for the UK HPR1000. Between November 2017 and June 2018, we have been providing advice on the contents of the submission and technical progress. We have also discussed detailed working arrangements covering matters such as document identification and tracking, and implementation of the comments process.

The JPO received the submission on 27 October 2017.

The individual documents of the submission are listed in Annexe 1 of this report.

The 'comments process' was launched on 16 November 2017, so that the public could view and comment on the submission. As part of this process:

- information about GDA and the comments process, with links to GNS's website, has been provided on the JPO website (http://www.onr.org.uk/new-reactors/)
- GNS has published its submission (apart from any sensitive nuclear or commercially confidential information) on its website, allowing comments to be made electronically or by post to GNS
- GNS has publicised its submission and the comments process by advertising the details on the UK HPR1000 GDA website http://www.ukhpr1000.co.uk
- the regulators also publicised the second phase of GDA and the comments process through the media and directly to stakeholders, https://www.gov.uk/government/news/second-phase-of-assessment-on-new-nuclear-reactor-for-uk-begins
- the appropriate regulator (ONR and/or the Environment Agency) has considered comments received up to 31 August 2018 and GNS's responses to those comments during its initial assessments
- comments received after 31 August 2018 will be considered during the next stage of assessment

We have carried out our initial assessment of the design. This is discussed in detail in sections 4 and 5 of this document and our conclusions are given in section 6 of this document.

We are aware that by 31 August 2018 GNS had received and responded to comments relating to the GDA process. These related to:

- the role of regulators assessing submissions and the involvement of companies from overseas in the UK nuclear power industry
- the relationship between generic and site specific assessment
- the need for further detailed information on environmental matters

We confirm that our GDA work is carried out and managed our own staff. If we use contractors to provided additional resources all regulatory decisions are made by regulators. Our work is based on the requirements and expectations of UK regulation and applies whatever the home country of the companies or designs that we are dealing with. Our assessment takes account of a generic site description, which in accordance with our guidance (Environment Agency, 2016) is defined by the requesting party, which we expect to reflect the relevant constraints of potential sites. If site specific proposals come forward these would have to reflect the characteristics of that site. We confirm that GNS is providing further information about the generic site and more generally for the UK HPR1000 for our next GDA step of Detailed Assessment..

3.2. Next steps

Our next step is to begin our detailed assessment and to come to a preliminary view on whether we might issue a Statement of Design Acceptability (SoDA), an interim Statement of Design Acceptability (iSoDA) with identified GDA Issues, or not issue either because the design is unsuitable. To do this, we will need the further information identified in Annexe 2. GNS will make this further information publicly available (apart from any sensitive nuclear or commercially confidential information) in the same way as the initial submission. Comments on all its published information can be made to GNS via its website.

Once we complete our detailed assessment, we will publish our preliminary views and invite comments through a public consultation exercise. We expect to begin this consultation in late 2020. We will carefully consider all responses to the consultation before deciding whether or not to issue a SoDA or iSoDA. The target for reporting our final decision is during winter 2021 to 2022.

4. Initial assessment - detailed level

As indicated in the P&ID (Environment Agency, 2016), our initial assessment has involved a more detailed examination of 3 aspects of the submission:

- GNS's management system for producing the submission
- the generic site description
- the assessment of the impact of proposed radioactive discharges

We discuss the management system in section 4.1 below. The generic site characteristics that are of interest to us are mainly those that are relevant when estimating the impact of discharges of radionuclides and non-radioactive substances, and of cooling water abstraction and discharge. There is considerable overlap between the generic site description and the assessment of the impact of proposed discharges. We consider these 2 aspects together in section 4.2 below.

4.1. General Nuclear System's management system

We have examined this aspect in some detail at this early stage to give us confidence in the quality of the submissions. Establishing this confidence supports our risk-based sampling approach for the detailed assessment stage, and confirms that our resources are being used appropriately. We want to know that:

- the design has been developed and the submission produced by suitably qualified and experienced people, including staff and contractors
- there has been an appropriate level of verification, review and approval of design and submission documents, including those produced by contractors, and the submission accurately reflects the design
- the design has been developed taking environmental requirements for all plant lifecycle stages into account
- design changes are, and will be, controlled, evaluated for their impact on the environment, recorded and reflected in the submission

GNS describes its GDA management system in the Preliminary Safety Report Chapter 20 - MSQA and Safety Case Management (document reference HPR/GDA/PSR/0020). We have examined this chapter and its supporting references, obtained via formal Regulatory Queries (RQs) to the Requesting Party, as part of our assessment.

In this document, we use the term 'safety case' to include safety, security and environmental aspects.

As well as examining this information, we and ONR visited GNS's offices in London, CGN's offices in Shenzhen, China and EDF's offices in Paris, France to evaluate how the management systems work in practice. The results of these inspections are included in inspection contact records ONR-NR-CR-17-794, ONR-NR-CR-18-087 and ONR-NR-CR-18-213.

The inspection objectives were to:

- check that GNS, as well as its service providers CGN and EDF, have quality management systems with organisational and procedural arrangements that adequately support production of the submissions
- establish that GNS has implemented and continues to review arrangements that adequately control its GDA-related activities
- inform our and ONR's assessment of GNS's submissions

During the 3 inspections, lasting a total of 10 days, we examined samples of the management system procedures and other documentation, and held discussions with relevant staff. Our joint Environment Agency and ONR findings are summarised below.

- Management systems and quality assurance arrangements within GNS, CGN and EDF are of an acceptable standard. CGN has formal accreditation to ISO9001 (quality management) and ISO14001 (environmental management) for its design and safety case roles. The EDF entities supporting the GDA project hold independent accreditation for their management systems, and while this does not formally cover EDF's GDA role, we are satisfied from our inspection that arrangements are adequate. GNS does not have formal International Standard Organisation (ISO) accreditation for its management systems, although it is committed to applying equivalent standards, including an independent audit. At the time of inspection, GNS's quality management arrangements were still being developed and implemented.
- Resource planning appears to be adequate, as does resource capacity for this stage in the GDA process. However, we highlighted to GNS that it needs to have sufficient resilience and flexibility in its resources to respond to peak workloads in subsequent stages of the GDA process.
- There appears to be a broad range of appropriate capabilities available across GNS, CGN and EDF to support the project, with further support from the commercial supply chain available if needed. At the time of inspection, further training was being scheduled to provide CGN staff with the necessary skills to assess and implement best available techniques (BAT). We will evaluate how effective this has been as part of our ongoing discussions, and via further inspections in detailed assessment.
- In all organisations, there was a healthy culture of learning from experience and continuous improvement, with examples of working and organisational arrangements being adapted, as they gained greater experience of using management arrangements.
- We observed some potential opportunities to improve arrangements for developing and reviewing the technical aspects of safety case submissions, including:
    - GNS taking a formal role in providing technical support for and review of developing safety case submissions
    - GNS and EDF liaising earlier with CGN designers and safety case chapter authors where there are technical matters relevant to the demonstration of BAT
    - the degree to which supplementary documents are subject to review
    - clarity in governance and decision making for directing issues that need resolving to the GNS Technical Committee
- We noted challenges in managing the development of safety case submissions, for example where the documents are developed beyond those versions provided to EDF for formal technical review but before those reviews have been completed. As the design process moves forward, we will be looking for assurance that high standards of document scheduling, quality control and records retention will be used to support the developing design and safety case, up to final transfer to potential operators.
- There are examples of inconsistent use of the term 'safety' across and within the different organisations, such as where 'environment' is sometimes in scope, sometimes out of scope. We also noted that within CGN there is very limited consideration of environmental objectives and performance within the development of a safety culture for the project, and within EDF there is no explicit definition of safety culture.

We had not received any comments relating to GNS' management system by 31 August 2018.

Our conclusion is that GNS Ltd and its service providers, EDF and CGN, operate appropriate and adequate management systems, which include and integrate aspects that control the content and accuracy of the Requesting Party's submissions to the JPO. Although at the time of our inspections, some organisational and management arrangements were still being implemented, and the effectiveness of working arrangements was still evolving, we consider the arrangements to be satisfactory for this stage of the GDA process. We are confident that the production and update of submissions will be adequately controlled, and that any issues raised will be properly dealt with.

We will return to the identified opportunities for improvement, and any currently outstanding management system and quality assurance arrangements as part of our detailed assessment to make sure that they have been addressed satisfactorily.

4.2. Generic site description and assessment of the impact of proposed radioactive discharges

The purpose of examining these aspects in detail at this stage is to make sure that the relevant constraints of potential sites (that is, those listed as potentially suitable in the National Policy Statement for Nuclear Power Generation (UK Parliament, 2011a) (NPS EN-6)) are appropriately reflected, and to provide early assurance that dose constraints will be complied with.

4.2.1. Site characteristics

The generic site characteristics that are of interest to us include:

- weather and other parameters affecting gaseous dispersion and deposition
- hydrographic and other parameters affecting aqueous dispersion
- location of nearest food production, human habitation, sensitive habitats and species
- food consumption rates and other human habits data
- availability of water for abstraction

The submission discusses the generic site in the document 'Generic Site Report' *(*HPR/GDA/REPO/0015). This report covers 3 main aspects of the generic site:

- the generic site envelope for external hazards (section 6)
- the generic site information for site suitability (section 7)
- the generic site characteristics (environment) (section 8)

The generic site characteristics are:

- an estuarine/marine environment
- flat topography
- no water extraction from aquifers
- no standing water at the site
- no planned releases to groundwater
- no freshwater bodies on or adjacent to the site
- the nearest human receptors are a fisherman's family and a local resident family

Discharge routes are gaseous aerial discharges and liquid discharges to the coastal/estuarine environment. No incinerator is planned to be built on site. The distance from the point of release to the site boundary is 100 m. The effective stack height for gaseous releases is assumed to be 20 m, which is likely to be a cautious assumption. The effective stack height is lower than the proposed physical stack height to account for effects from adjacent buildings.

For the generic site, aqueous releases are to an estuarine environment that is similar to the estuarine environment around the Bradwell site. It is likely that the Bradwell site characteristics have been selected, as this is where it has been proposed that the UK HPR1000 could be built. The atmospheric meteorological conditions are drawn directly from the Environment Agency Initial Radiological Assessment Tool (IRAT) model (Environment Agency, 2006a and 2006b) based on the Pasquill atmospheric dispersion scheme - 50% category D, 5 m/s wind speed, uniform wind rose and an 800 m boundary layer. The distances from the atmospheric release points to people resident near the site (100 m) and food production (500 m) are taken from the IRAT system.

As part of the assessment, it was noted that adopting the IRAT assumptions for the generic site had not been justified against the generic site characteristics. The parameters used in IRAT, which are based on International Atomic Energy Agency (IAEA) recommended values, may no longer be up to date. We would have expected appropriate adjustments to be considered. We have issued Regulatory Query RQ-UKHPR1000-0063 related to selecting IRAT as a modelling tool.

4.2.2. Dose assessments for members of the public and non-human species

Our P&ID (Environment Agency, 2016) asks the Requesting Party to provide radiation dose assessments including:

- annual doses from gaseous and liquid radioactive discharges and direct radiation (separately and in total)
- potential short-term doses based on the maximum anticipated short-term discharges from the facility in normal operation
- collective dose to the UK, European and world populations
- dose rate to non-human species

Dose assessments are provided in Preliminary Safety Report, Chapter 26 on Environment (document reference HPR/GDA/PSR/0026).

In PSR chapter 26 the annual doses from gaseous and liquid radioactive discharges and direct radiation are presented. The discharge estimates provided are based on theoretical calculations using the Chinese regulatory methodology and assumptions and are assessed at a principle level only in our initial assessment. This assessment can be found in section 5.2 of this report. For detailed assessment, UK HPR1000, discharge estimates are expected to be based on operational data supplemented with modelled data where necessary.

As further work on the discharge estimates is carried out for detailed assessment, there may be minor changes to the discharge estimates used in this dose assessment. Therefore, it is important that the final discharge estimates are derived as soon as is practical to allow the final assessment of doses to be completed. This includes demonstrating an understanding of the variability of discharges over an operating cycle to inform the assessment of a short duration release.

The methodology is based on the Environment Agency Initial Radiological Assessment Tool, IRAT (Environment Agency, 2006a and 2006b), stage 1 and stage 2. An IRAT stage 1 assessment is a very cautious assessment, assuming a gaseous release at ground level or a liquid release into an environment with a low volumetric exchange rate. A stage 2 assessment is slightly less cautious, as it allows the user to increase the release height for a gaseous discharge and increase the volumetric exchange rate, which increased dispersion for liquid releases. A stage 3 assessment allows greater flexibility where the assessment can include more complex models and be tailored to specific parameters. This is a realistic assessment.

Annual dose to the public from liquid discharges under a stage 1 assessment is 0.0084 mSv/y. For the stage 2 assessment dose is 0.0065 mSv/y - reduced slightly compared with the stage 1 assessment as a result of using a slightly increased volumetric exchange rate, to represent a more dispersive environment. Dose from gaseous discharges using IRAT stage 1 assessment is 0.069 mSv/y. For the stage 2 assessment dose is 0.0064 mSv/y - reduced by a factor of 10 compared with the stage 1 assessment. The ten-fold reduction in doses arises from the higher effective stack used in the stage 2 assessment. We note that all doses are well below UK limits.

The method used is based on IRAT for stage 1 and stage 2 and the Requesting Party has not justified why IRAT is appropriate to use for the assessment. We have raised RQ-UKHPR1000-0063 on the use of IRAT and the parameters in IRAT, some of which are taken from older IAEA publications.

The PSR was not clear whether the assessment will be taken to the more detailed stage 3. We raised RQ-UKHPR1000-0061 to ask whether a stage 3 assessment will be made. GNS has now committed to completing a more detailed stage 3 assessment.

To verify GNS's dose assessment, we repeated the stage 1 and stage 2 assessments using IRAT and the assumptions used by the Requesting Party, which estimated a similar dose.

The Requesting Party has assessed direct radiation dose to the public. The assessment is based on simplified assumptions about the dose rate of 1 mSv/y close to the buildings that are a source of direct radiation. The basis for this 1 mS/y assumption is not clear. The assessment assumes that the person is 100 m from the direct radiation source, with modelling to determine the dose rate at 100 m. The assessment of direct radiation dose to the public should originate from the radiation protection chapter (chapter 22) of the PSR (document reference HPR/GDA/PSR/0022). Currently the radiation protection chapter 22 has very little detail on public dose from direct radiation: chapter 22 text refers back to chapter 26. The direct radiation dose given is 0.0055 mSv/y. The direct radiation methodology needs further refinement for detailed assessment.

Total annual dose from gaseous and liquid discharges (stage 2 assessment) is 0.0129 mSv/y. The total annual dose from gaseous and liquid discharges (stage 2 assessment) and direct radiation is 0.0184 mSv/y.

Short duration releases have been assessed for the maximum anticipated short-term discharge to atmosphere from the facility during normal operations. The impact through the food chain is likely to be a factor due to the expected increased release of carbon-14 (C-14) during outage. The assessment is for a 24-hour long discharge at the maximum monthly discharge. The short-term dose was estimated as 0.0048 mSv, and is dominated by C-14 from food ingestion. C-14 contributes approximately 87% of the total short-term dose. We have raised RQ-UKHPR1000-0062 on the method used for the short duration release assessment, including the food chain modelling. This is because the method used to calculate short-term doses from releases to atmosphere is not presented very clearly. The document refers to the use of PC-CREAM 08 for this assessment. However, PC-CREAM 08 is suitable for an assessment of ongoing and continuous releases, but not for short duration releases. However, we note that when the short duration impact is added to the total impact the result is still well below UK dose limits.

Collective doses truncated to 500 years, per year of discharges from gaseous releases and liquid releases to UK, Europe and the world have been assessed. The collective doses from gaseous releases range from 0.22 man.Sv/y to the UK population up to 7.4 man.Sv/y to the global population. The collective doses from liquid releases range from 0.004 man.Sv/y for the UK population to 0.22 man.Sv/y to the global population. The collective dose is dominated by C-14 discharges.

An assessment was carried out for reference organisms in both terrestrial and marine ecosystems using the ERICA model. Both tier 1 and tier 2 assessments were carried out. Tier 1 uses Environmental Media Concentration Limits (EMCLs) to estimate risk quotients. Tier 2 calculates dose rates, but allows the editing of parameters to represent the proposed discharge. The R&D128 assessment tool (Environment Agency, 2015) was also used to assess the impact of noble gases on non-human species, with some additional modelled nuclide concentrations.

The parameters for the modelling were presented, however there was no justification explaining that model selection or parameterisation was appropriate. Specifically, we note that R&D128 does have an alternative option available, but it is not clear why R&D128 was selected for use.

As for the human dose, the assessed wildlife dose rates are dependent on the final discharges source term, which will be subject to further work by the Requesting Party. It is important that the final discharges are finalised as soon as is practical to allow the assessment of dose to be finalised.

There are a number of dose limits and constraints which any new nuclear plant would have to meet.

The **source dose constraint** (as defined in EPR16) is 0.3 mSv/y. It applies to the dose from proposed discharges and direct radiation from a new single source. The assessed total annual dose (from discharges and direct radiation) to the representative person of 0.0184 mSv/y is within the source constraint.

The **site dose constraint** (as defined in EPR16) is 0.5 mSv/y. It applies to the total dose from the current discharges from all sources at a single location, including discharges from immediately adjacent sites; doses arising from direct radiation and historical discharges are not included. All the sites listed in our National Policy Statement, NPS EN-6 (UK Parliament, 2011a) as potentially suitable for a new nuclear power station are adjacent to existing nuclear sites. Of these, Sellafield has the highest assessed dose for discharges at currently permitted discharge limits, at 0.074 mSv/y (Environment Agency et al., 2017). Adding this to the assessed dose from discharges for the UK HPR1000 of 0.0129 mSv/y, (based on the IRAT stage 2 assessment) gives a value, 0.0869 mSv/y, which is within the site constraint.

The **dose limit** (as defined in EPR16) for members of the public is 1 mSv/y. It applies to the total dose from the future discharges from the site, direct radiation from the site, future discharges from other sources near the site, direct radiation from other sources near the site, and the residue of radioactivity in the environment from past discharges. Of the sites listed in NPS EN-6 (UK Parliament, 2011a), Sellafield on the West Cumbrian Coast also has the highest dose from direct radiation and historic discharges. The total dose in 2016 was 0.074 mSv/y. In addition, the West Cumbrian Coast environment around Sellafield has been affected by past discharges from a phosphate works - the dose from these residues is 0.34 mSv/y, giving a total of 0.41 mSv/y (Environment Agency et al., 2017). Adding this to the assessed total dose for the UK HPR1000 of 0.0184 mSv/y, gives a value, 0.428 mSv/y, which is within the dose limit.

For non-human species, we use an action level of 40 µGy/h. This is the dose rate below which we consider there will be no significant adverse effects on the integrity of protected Natura 2000 sites. As non-human species may be affected by discharges from more than one site, we also use a screening level of 10 µGy/h when considering the impact from a single source.

The highest assessed dose-rates for terrestrial organisms, from gaseous discharges, (2.54×10^{-3} µGy/h) and marine organisms, from aqueous discharges, (3.95×10^{-2} µGy/h) are all below the screening level. Similar values were obtained using the Environment Agency Initial Radiological Assessment Tool (IRAT) stage 2. The dose-rates for freshwater organisms were not calculated, as the generic site is assumed to be coastal with no radioactive discharges to river or groundwater. If a different site is chosen at the site-specific stage, freshwater dose-rates to non-human species may need assessing.

We are aware that by 31 August 2018 GNS had received and responded to comments relating to dose assessment. These related to:

- the need for the dose assessment to use the most up to date and appropriate information
- questions about source term

We have considered these comments and the response provided by GNS during our initial assessment. We check that the impact assessment methodologies that are used are aligned with current UK best practice, which is based on the latest peer-reviewed scientific information.

As noted above, UK HPR1000, discharge estimates are expected to be based on operational data supplemented with modelled data where necessary, which we will assess during our Detailed Assessment stage.

Our conclusion is that for a coastal site:

- the annual dose constraints and limits will be met by this design
- the action level for non-human species will be met by this design

We have raised RQ-UKHPR1000-0061 asking whether a stage 3 assessment will be made. GNS have committed to carry out a stage 3 assessment. We have raised RQ-UKHPR1000-0062 on the method used for the short duration release assessment, including via the food chain. This is because the method used to calculate short-term doses from releases to atmosphere is not presented very clearly. We issued RQ-UKHPR1000-0063 related to the selection of IRAT as a modelling tool.

Further requirements are provided in 2.1 to 2.5 in Annexe 2 of this report.

5. Initial assessment - principle level

This section discusses the rest of our initial assessment, covering those matters where our assessment has been carried out at a 'principle' level, that is, where the Requesting Party's statements and assertions have been accepted at face value with only very limited scrutiny of the supporting detail.

5.1. Radioactive waste management arrangements

Our P&ID (Environment Agency, 2016) asks the Requesting Party to provide a detailed description of the radioactive waste management arrangements, mainly addressing the 3 aspects discussed below.

5.1.1. Strategic considerations

We ask the Requesting Party to identify the strategic considerations, with respect to radioactive waste management, that underpin the design. Our Radioactive Substances Regulation - Environmental Principles (REPs) (Environment Agency, 2010a), at principle RSMDP1, indicate the matters to be considered. Additionally, 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 will be disposed of to a geological disposal facility (GDF) that the government will construct (UK Parliament, 2011b). Since these disposals are unlikely to begin until late this century, this effectively means that the strategy needs to include provision for on-site storage of both intermediate level waste (ILW) and spent fuel for the lifetime of the plant, or an appropriate alternative.

The submission refers to strategic considerations in Chapter 23 of the Preliminary Safety Report entitled Radioactive Waste Management and Fuel Storage (document reference HPR/GDA/PSR/0023). Strategic considerations for decommissioning are considered in Chapter 24, Decommissioning (document reference HPR/GDA/PSR/0024).

The submission does not fully address the P&ID requirement to identify 'the strategic considerations with respect to radioactive waste management which underpin the design'. The relevant UK strategies and legislation with which GNS must comply are identified, together with potential waste management options within the UK. Therefore, UK strategic considerations are recognised. Appropriate principles for decommissioning are also specified in PSR chapter24. However, the submission does not detail the strategic considerations for the UK HPR1000 design or explain how GNS has taken the identified principles into account. GNS does not commit to specific treatment and disposal options at this stage.

The chapter does not present a strategy for managing radioactive waste for the UK HPR1000. GNS advises that the information provided is based upon the Reference Plant, the Chinese Fangchenggang unit 3 (FCG-3) design. It also recognises the need to develop radioactive waste management arrangements for a UK context.

Through our technical meetings with the Requesting Party, we understand that GNS is due to submit its integrated waste strategy around February 2019. Some preliminary waste volumes and proposed treatment options and equipment have also been proposed based on FCG-3. GNS recognises that further work is needed to update the UK HPR1000 design in light of UK waste management practices.

Our conclusion, at the principle level, is that strategic considerations require further development. The Requesting Party needs to demonstrate how the UK strategic considerations have been addressed in the UK HPR1000 design.

For our detailed assessment, we will need further information as set out in item 3.1 of Annexe 2, which is an integrated waste strategy, or radioactive waste management strategy that sets out how the UK strategic considerations have been addressed in the UK HPR1000 design.

5.1.2. - Identification of radioactive waste arisings and proposals for management and disposal

We asked the Requesting Party to describe how radioactive waste and spent fuel will arise throughout the facility's lifecycle, including decommissioning, and how the waste will be managed and disposed of.

The submission addresses this topic as presented in PSR chapter 23, radioactive Waste Management (document reference HPR/GDA/PSR/0023).

Solid waste

Radioactive waste is produced within the UK HPR1000 by a number of processes, and is classified into 3 main types: liquid, gaseous and solid waste.

Liquid waste is produced mainly from systems that collect and treat the reactor coolant water, the spent-fuel storage pond, plant decontamination and drainage from change rooms and the active laundry. It will be treated by filtration, ion exchange and evaporation before being discharged via pipelines.

Gaseous waste arises mainly from the ventilation of gases from the primary water coolant circuit. It will be treated by high efficiency particulate air filtration (HEPA filtration) and charcoal delay beds before being discharged via an approved stack.

The solid waste generated is classified into the following categories: high level waste (HLW), intermediate level waste (ILW), low level waste (LLW), and very low level waste (VLLW). GNS provides an overall summary of the solid waste that will be produced over the operational lifecycle of the reactor within table T-23.4.1 of PSR chapter 23. The typical waste produced includes spent resins, low activity resins, concentrates, spent filters and dry active waste. Further information with regard to these types of waste and how they will be managed is provided within PSR-23. However, this information is lacking in detail with regard to volume, activity and the constituents of the waste. GNS has also not provided detailed information on the predicted arisings of solid waste during decommissioning. We will need this information to carry out detailed assessment for GDA.

GNS has also stated in PSR chapter23 that all solid waste produced will have a disposal route. We questioned whether any additional waste that could be problematic will be produced during the lifecycle of the reactor. We have also requested that GNS identifies boundary waste and the options for its disposal. Boundary waste is that which is expected to be close to the LLW/ILW classification boundary. We have raised RQ-UKHPR1000-0141 to determine whether this type of waste will be produced. We are satisfied with the information provided at this stage in the GDA process, but will require GNS to provide further information in support of a detailed assessment.

With regard to applying the waste management hierarchy (WMH) and BAT, the Requesting Party has provided several examples where the reactor design will prevent and minimise the creation of radioactive waste or minimise final package volumes. For further information on our initial assessment of BAT see section 5.1.3 of this report.

GNS has provided limited information with regard to the interim storage of higher activity solid waste prior to its disposal. ILW packages will have to be stored at the site for up to 100 years before being disposed of to a future GDF. The Requesting Party will have to provide further information so we can carry out a detailed assessment of these arrangements and we will expect to see this covered in the submission for detailed assessment.

GNS highlights that it will be liaising with the Low Level Waste Repository (LLWR) and Radioactive Waste Management Limited (RWM) in the future regarding the treatment and disposal of LLW and high activity waste (HAW). This engagement is at an early stage in the disposability of waste both for LLW and HAW, and therefore we need to see further detail during the detailed assessment stage of the GDA process.

Spent fuel

Table T5.2-1 in the PSR- chapter 5 (document reference HPR/GDA/PSR/0005), Reactor Design Parameters, contains details of the reactor core/fuel assembly design. The target minimum average discharge fuel assembly burn up is greater than or equal to 47,000 MWd/tU (megawatt days per tonne of uranium), this is similar to other PWRs. There is no information within the PSR that provides us with an overview of the estimated number of spent fuel assemblies that will be produced over the lifecycle of the reactor, although we note an outage for refuelling will take place approximately every 18 months. This information should be provided for detailed assessment.

GNS has provided a good overview of spent fuel operations from the loading of fuel into the reactor to its removal and subsequent cooling and interim storage. The number of spent fuel units used will ultimately have an impact on the storage capacity of the site and also the capacity with a future GDF. In applying BAT, we would wish to see the generation of spent fuel being optimised. GNS has indicated it intends to do this by optimising the duration of the operating cycle, being able to detect, locate and isolate leaking fuel pins and ensure that they are subsequently removed. This demonstrates that GNS plans to apply BAT to the generation of spent fuel assemblies. However, the claims within the PSR are not supported by any operational experience (OPEX) data or evidence from the wider international community. The Requesting Party will, therefore, have to provide this information for detailed assessment.

GNS has demonstrated that it has a good understanding of the options available for the interim storage of spent fuel. We note that GNS will be carrying out an optioneering study to identify the preferred option going forward with regard to interim storage of spent fuel. GNS has stated that the scope for the spent fuel interim storage facility (SFIS) will be high level only at GDA and neither a concept nor detailed design will be developed. We will continue to liaise with GNS to understand the proposals for the SFIS and to consider if the information provided at later stages of GDA is sufficient. The information GNS provided at this stage in the process is adequate and we note that it has committed to provide further information for detailed assessment.

It is not clear from the information presented in the PSR chapter 23 how GNS plans to manage any failed fuel as part of the interim storage phase. We note that GNS states: “There will be sufficient storage cells dedicated for damaged spent fuel assemblies located in the spent fuel pond (SFP) for the entire reactor operation lifetime such that decisions to select the SFIS technology is not required at this stage.” We will expect to see information to support the expected number of failed fuel assemblies for detailed assessment.

GNS has yet to formally engage with RWM with regard to the disposability of spent fuel. GNS has not specified how spent fuel will be conditioned and packaged for interim storage and final disposal. We are aware that GNS has plans to engage with RWM and that this information will become available as we progress through GDA.

We are aware that by 31 August 2018 GNS had received and responded to comments relating to option selection for interim storage of spent fuel. We have considered the respondent's view that the information presented is biased, and the response GNS provided, noting that the information is still being developed as part of our initial assessment. We can confirm that as part of our Detailed Assessment we will expect GNS to provide a balanced and evidenced option selection for interim storage of spent fuel.

Our conclusions, at the principle level, are:

- there is limited information with regard to the storage and disposal of waste at this stage, but we are aware that GNS plans to address this at the next step of GDA
- there is limited information with regard to the decommissioning plans for the UK HPR1000 and waste arisings, but we are aware that GNS plans to provide this at the next step of GDA
- information on the estimated number of fuel assemblies that will be produced over the lifecycle of the reactor should be provided
- further information should be provided to support claims with regard to applying BAT and the WMH to optimise the production of spent fuel wastes and packages
- information with regard to interim storage of spent fuel is adequate for this stage, but requires more information as we progress through GDA
- there is limited information with regard to conditioning and packaging of spent fuel and further information on this and disposability will be required

For our detailed assessment, we will need further information as set out in items 4.1 to 4.7 of Annexe 2.

5.1.3. Protecting people and the environment

We ask the Requesting Party to describe how the production, discharge and disposal of radioactive waste will be managed to protect the environment and to protect people. We expect GNS to do this by demonstrating that its management and disposal plans (as discussed in the previous section) represent use of best available techniques (BAT). In justifying BAT, the Requesting Party should address these key permit conditions and show how they are:

- preventing and minimising (in terms of radioactivity) the creation of radioactive waste
- minimising (in terms of radioactivity) discharges of gaseous and aqueous radioactive waste
- minimising the impact of those discharges on people and adequately protecting other species
- minimising (in terms of mass/volume) solid and non-aqueous liquid radioactive waste and spent fuel and selecting optimal disposal routes for them
- the suitability for disposal of any waste and spent fuel for which there is no currently available disposal route and how it will be managed in the interim so as not to prejudice their ultimate disposal

A more detailed description of BAT is given in our guidance (Environment Agency, 2010b).

The GNS submission for initial assessment addresses BAT in chapter 23, section 23.6, of the Preliminary Safety Report (PSR), (document reference HPR/GDA/PSR/0023).

The document is based on the reference plant (FCG-3) and does not yet contain a detailed description of the proposed radioactive waste management systems to be included in the UK HPR1000.

The document is structured such that the high level claims align closely with the bullet points within the P&ID (Environment Agency, 2016), and those permit conditions listed above. For each claim, supporting text is included, defining some appropriate arguments. The arguments made are not yet supported by detailed evidence. GNS will be expected to provide the necessary evidence for detailed assessment as GDA progresses. It is not yet clear if the claims were developed by using a systematic approach and are, therefore, complete or whether new claims may be added.

We expect the dose impact assessment, as discussed in section 4.2.2, to be used to identify and prioritise investigations into the possibility of improvements to the HPR1000 reference design for deployment in the UK as the UK HPR1000. There is a noticeable absence of any consideration of minimisation of carbon-14 in gaseous discharges in the PSR, which is a dominant contributor to public dose impact. By contrast, minimising tritium by using ‘enriched boron’ and ‘depleted lithium hydroxide’ is discussed, as was a commitment to look into potential abatement of tritium and carbon-14. Through discussion in technical meetings, GNS has committed to consider minimising carbon-14 as part of the submissions for detailed assessment. We will expect this to be given serious consideration.

From the information presented, we note that the design does appear to align with some of the high level objectives expected in demonstrating BAT, such as waste segregation, applying the WMH, selecting optimal disposal routes and using concentrate and contain (in preference to dilute and disperse).

Examples of appropriate objectives of the UK HPR1000 include:

- using low cobalt steel alloys, where practicable, to avoid activity in solid waste from activation products
- using boric acid enriched in boron-10 to control reactivity while minimising tritium generation
- using lithium hydroxide depleted in lithium-6 to control pH while minimising tritium generation
- using HEPA filtration and charcoal delay beds as abatement in the gaseous waste treatment system to minimise activity discharged to air (particulates, noble gases and iodine)
- segregating liquid effluent streams to optimise abatement before discharge to minimise activity in discharges to the environment

- using ion exchange as abatement in the liquid waste treatment system to minimise activity discharged to the environment
- recycling liquids where practicable to minimise volume of liquid discharges
- appropriate waste characterisation to ensure optimal waste management and disposal route selection
- considering decay storage where feasible to reduce final waste classification

However, all these statements require GNS to supply detailed supporting evidence during detailed assessment. GNS has committed to provide the necessary information.

While the information presented in the PSR is logical and is in line with the P&ID requirements, it lacks a wider understanding of BAT as noted in our Radioactive Substances Regulation - Environmental Principles (REPs) (Environment Agency 2010a) and some key aspects expected of a BAT assessment as defined in the Environment Agency guidance, 'RSR Principles of optimisation in the management and disposal of radioactive waste' (Environment Agency, 2010b).

For example, regulators require the Requesting Party to:

- set up the necessary management arrangements, including selecting appropriate staff to be involved (for example, suitably qualified and experienced personnel)
- carry out a proportionate and systematic determination of BAT
- record and justify the optimised outcome

The first point has been assessed as part of our assessment of the management arrangements (see section 4.1).

From technical dialogue with the Requesting Party, we are aware that it is developing a BAT methodology, including the development of a detailed claim-argument-evidence structure. We are expecting the methodology to be submitted before the start of the detailed assessment phase of GDA, which is due to begin in November 2018. This should describe a systematic and proportionate approach to the demonstration of BAT, which, in turn, will ensure all aspects are captured, and will allow GNS to develop a programme of work to collect the appropriate evidence for the claims and arguments made. However, this was not available for assessment during this initial assessment stage of GDA.

We note that the Requesting Party has developed a process to align both BAT and ALARP (As low as reasonably practicable) optimisations to ensure a single optimised outcome to any option selection undertaken (ALARP & BAT - Principles and Requirements for the UK HPR1000 GDA, HPR/GDA/PROC/0089 Rev 0). [Demonstration that risks are ALARP is required by ONR as part of its regulatory decision making].

In principle, we agree with this objective, but will fully assess the documentation as a complete package when the BAT methodology is available as part of detailed assessment to assess whether this objective is achieved. We note that BAT includes both the choice of technique and how that technique is implemented, and we will expect to see both aspects of BAT considered in GDA as far as practicable.

We are aware that by 31 August 2018 GNS had received and responded to comments relating to materials choices for the UK HPR1000 design. As stated above, we will assess the supporting BAT evidence with respect to the UK HPR1000 objectives during our Detailed Assessment stage.

Our conclusion, at the principle level, is that the analysis of BAT requires further development, particularly in the areas of:

- providing detailed information on proposed radioactive waste management systems
- defining a systematic approach for demonstrating BAT
- demonstrating that BAT is influencing the reference design (HPR1000) for deployment in the UK (as the UK HPR1000)
- demonstrating that the prioritisation of potential improvement to the HPR1000 is related to public dose impact (or non-human species dose rate impact)
- identifying and presenting the necessary evidence to support the BAT claims and arguments

- considering both technique selected and how the selected technique is used

For our detailed assessment, we will need further information as set out in items 5.1 to 5.6 of Annexe 2.

5.2. Quantification and assessment of radioactive waste disposals

We asked the Requesting Party to provide numerical estimates for:

- discharges of gaseous and aqueous radioactive waste
- arisings of combustible waste and disposals by on-site or off-site incineration
- arisings of other radioactive waste (by category and disposal route (if any)) and spent fuel

The estimates should allow for the operational fluctuations, trends and events that are expected to occur over the lifetime of the facility, such as start-up, shutdown, maintenance, as well as predicted equipment/systems faults, for example, fuel failures. They should not include increased discharges arising from other events, inconsistent with the use of BAT, such as accidents, inadequate maintenance, and inadequate operation.

The estimates are needed to support the assessment of the impact of the discharges and the BAT analysis, and to provide a basis for limit setting. It is UK government policy that discharges and waste arisings from new nuclear power stations should not exceed those of comparable power stations across the world (UK Parliament, 2008).

We also ask the Requesting Party to propose annual limits (on a rolling 12-month basis) for gaseous and aqueous discharges, together with 'campaign' limits (for example, to reflect an operating cycle) if it thinks these are appropriate. If on-site incineration of combustible waste is planned, we ask the Requesting Party to propose monthly limits for disposals by this route. We expect the proposed limits to be consistent with our limit-setting guidance (Environment Agency, 2012).

The submission provides estimates of discharges in section 26.3.1 of Chapter 26 of the Preliminary Safety Report (document reference HPR/GDA/PSR/0026).

The submission presents estimated discharges for a large number of nuclides based on the Fangchenggang unit 3 reference plant (FCG-3), but provides no information on how the numbers were derived or any justification and supporting evidence for the validity of the numbers or their associated uncertainty. We note FCG-3 is currently under construction in China and, therefore, we do not consider that unsubstantiated estimates based on an as yet unbuilt plant would be sufficiently robust for GDA.

We do recognise that the discharge estimates for FCG-3 are based on theoretical calculations based on the Chinese regulatory methodology, but these are not underpinned by operational data. It is for this reason that we raised RQ-UKHPR1000-0076, seeking clarity on how data would be used to support the estimates for the UK HPR1000. The response we received showed, in outline, that operational data would be sourced from China and France.

We will expect to see robust evidence for the relevance of the data on which the estimated annual discharges of aqueous and gaseous radioactive waste from the UK HPR1000 have been based, including the associated uncertainty.

The OPEX based estimates of discharges of aqueous and gaseous radioactive waste are likely to account for normal operations with associated fluctuations for expected events and should not obviously include events which might be described as incidents. However, without understanding the events included in the OPEX data, we cannot see whether all events likely to occur during the lifetime of the plant will have been captured. We will expect to see a methodology for and evidence to support what events are considered likely to occur over the lifetime of the plant, and that they are included in the derivation of the discharge estimates.

The submission discusses the likely variability of the discharges over time on a qualitative basis, but no numerical information is provided. There is a reference to peak discharges over a month meeting a Chinese regulation on the worst case monthly discharge, but this approach is not applicable to the UK. We will expect to see evidence on which the estimated monthly discharges of aqueous and gaseous radioactive waste from the UK HPR1000 have been based.

The submission does use the Environment Agency limit setting guidance (Environment Agency, 2012) to identify those nuclides that are significant and that will be required to have a discharge limit under permitting. However, there is no explanation or justification for those nuclides selected which are not defined on a threshold basis, such as performance indicators. We will expect to see this for detailed assessment.

The submission does propose annual limits for the significant nuclides identified. However, it does not consider the need for a headroom factor to account for any uncertainty in deriving the discharge estimates. We will expect to see a statistical analysis to support a headroom factor applied to the estimated discharges to derive proposed limits.

The Requesting Party has yet to submit information on how the discharges compare to those from similar stations worldwide. However, we note that the estimated discharges of both aqueous and gaseous radioactive waste and the proposed discharges limits for them are broadly similar to discharges from Sizewell B Power Station, a similar plant operating in the UK. We will expect to see the Requesting Party present a wider comparison for detailed assessment.

The Requesting Party has yet to submit any quantitative information for likely solid waste or spent fuel disposals.

We have discussed with GNS all the missing information noted above, and it has committed to provide this for detailed assessment.

We are aware that by 31 August 2018 GNS had not received substantive comments relating to quantification of radioactive waste disposals.

Our conclusions, at the principle level, is that the current information is not detailed or robust enough to allow a detailed assessment of the estimated discharges.

For our detailed assessment, we will need further information as set out in items 6.1 to 6.6 of Annexe 2, including:

- we will expect to see robust evidence on which the estimated annual discharges of aqueous and gaseous radioactive waste from the UK HPR1000 have been based
- evidence of what expected events are likely to occur over the lifetime of the plant and that they are included in the derivation of the discharge estimates
- a statistical analysis of the evidence on which the estimated monthly discharges of aqueous and gaseous radioactive waste from the UK HPR1000 have been based
- a derivation of a statistical method to define proposed discharge limits based on estimated monthly discharges of aqueous and gaseous radioactive waste for the UK HPR1000
- a comparison of discharges with comparable plants on a worldwide basis
- quantitative information on likely solid waste and spent fuel disposals

5.3. Measurement of discharges and disposals of radioactive waste

We asked the Requesting Party to describe the proposed sampling arrangements, techniques and systems for measuring and assessing discharges and disposals of radioactive waste, including in-process monitoring arrangements as well as those for final discharges.

The submission briefly describes final liquid and gaseous discharge monitoring arrangements in PSR chapter 26, section 26.3.2 (document reference HPR/GDA/PSR/0026). The submission states that information on the arrangements for in-process monitoring will be provided in later stages of GDA, although the areas included for the HPR1000 (FCG-3 reference plant) are listed. No details of the arrangements for monitoring solid waste and non-aqueous waste have been included.

Gaseous discharges will be released via a single stack. It is stated that this final discharge point will be sampled and monitored in accordance with ISO:2889:2010. Samples will be representative of the overall discharge, taking into account mixing and particulates. The nature and number of sampling probes will be determined through the BAT process at a later stage of GDA and eventually through site-specific permitting. It is stated that the sample line from the sample extraction point to the sample collection and monitoring location will be kept as short as possible and with a minimum number of bends and horizontal sections as is reasonable to reduce the loss of material. For detailed assessment, the Requesting Party will need to demonstrate that the particle penetration factors required by international standards are met.

Gaseous flow measurement within the stack is also required, using an MCERTS flow meter is currently seen as good practice and may become a requirement in future. GNS has committed to using an MCERTS accredited flow meter.

At this stage, it is not clear whether there will be a spare port in the stack to enable periodic calibration and performance checks of monitoring systems and provide stack access for any future requirements. GNS has indicated that the proposed access platform on the stack is not designed to meet our M1 guidance (Environment Agency, 2017). We have requested that further work is carried out in this area to ensure that the platform and stack access allows all the requirements of the appropriate standards to be met.

Aqueous discharges will be released via the outfall. The submission recognises that discharge of liquid radioactive effluent into the environment should be sampled and measured upstream of the discharge point in the storage tanks, and be monitored continuously before the discharge control valves. For the UK HPR1000 sample collection, it is proposed that MCERTS accredited flow proportional samplers will be employed. The tanks will be well mixed by using a recirculation line before being discharged to the main outfall, allowing for representative samples to be collected.

Aqueous flow measurement is also required in the final outfall and a commitment to use an MCERTS accredited flow meter has been made.

It is stated for both gaseous and aqueous discharges that the final sampling method, along with the analytical methods, will be selected to ensure that the appropriate detection limits can be achieved, as required by the EU (EU, 2004). Currently there are some analytes that are seen as key radionuclides for EU, 2004, where the monitoring arrangements have not been addressed, further consideration of these (i.e. strontium-90 and total alpha) is ongoing.

GNS is aware of the requirements for independent monitoring of both gaseous and aqueous discharges and states that these systems will be developed at a later stage of the GDA process.

We are aware that by 31 August 2018 GNS had not received any comments on the measurement of radioactive waste discharges and disposals by 31 August 2018.

Our conclusion, at the principle level, is that the proposals for measuring and assessing discharges and disposals of radioactive waste do not yet demonstrate BAT.

For our detailed assessment, we will need further information as set out in items 7.1 to 7.5 of Annexe 2.

5.4. Aspects related to other environmental regulations

We also ask the Requesting Party to provide information relating to regulatory requirements other than those associated with the disposal of radioactive waste, as set out below.

5.4.1. Water use and abstraction

We ask the Requesting Party to provide details and estimates of:

- fresh water requirements for the design
- cooling water requirements for the design relevant to the generic site

Abstraction of water from inland waters or ground waters will require a licence under WRA91. Abstraction from the open sea does not require a licence, but we have a regulatory interest in terms of the potential impact on fish, including with regard to The Eels (England and Wales) Regulations 2009. The cooling option chosen will also influence the discharges to surface waters discussed in the next section.

The submission describes process and cooling water requirements in chapter 26.4.1 of the Preliminary Safety Report (PSR) (document reference HPR/GDA/PSR/0026).

The submission outlines the freshwater usage in the nuclear island and conventional island demineralised water distribution systems. An assumption is made that all freshwater needs will be met by the local water company and, therefore, an abstraction licence would not be needed. No information is provided on the quantity of freshwater required, so no assessment on the validity of this assumption can be made at this stage.

The cooling water system is stated to be a once-through circulating water system which is usual practice for coastal sites. However, other than a list of possible options, there is no detail provided, but this is acceptable for GDA, as all marine infrastructure will be assessed in detail at the site-specific stage. The submission outlines the site systems that cooling water will be used in, but provides no detail on quantities required.

The submission contains very little information on biota deterrent and biota return systems, but does provide a commitment that this will be considered later during the permitting process.

As noted above we are aware that GNS has received and responded to comments relating to the need for further detailed information on environmental matters to be provided. We noted that GNS are providing further information for the next step of GDA, detailed assessment. Our guidance requires GNS to provide details and estimates of cooling water requirements for the design relevant to the generic site. This should Include; consideration of; seawater or river water abstraction, use of conventional cooling towers or hybrid cooling towers, abstraction inlet fish deterrent schemes, and fish return systems.

We note that full detailed consideration of abstraction and discharge arrangements can only be carried out if or when site-specific proposals come forward. This includes considering requirements arising from Convention for the Protection of the Marine Environment of the North-East Atlantic, (referred to as the Oslo-Paris Convention or OSPAR), including requirements relating to using BAT.

Our conclusions, at the principle level, are:

- an abstraction licence would not be needed based on the assumptions made by the Requesting Party and presented in its submission

The Requesting Party has not provided enough information to determine whether the design of the cooling water abstraction system will adequately protect fish, if the site-specific assessment shows a fish deterrent system is needed. For our detailed assessment, we will need further information as set out in items 8.1 to 8.4 of Annexe 2.

5.4.2. Discharges to surface waters

Discharges to surface waters of non-radioactive contaminants will require a permit under EPR16. We ask the Requesting Party to provide a description of how aqueous waste streams will arise, be managed and be disposed of, throughout the facility's lifecycle. We expect this to consider potential options and associated environmental impact for disposal of each individual effluent stream, including the environmental impact of thermal discharges.

The submission describes discharges to surface waters in chapter 26.4.2 of the Preliminary Safety Report (PSR) (document reference HPR/GDA/PSR/0026).

The submission contains no information on the following aspects:

- sources and quantities of contaminants, (including disinfectant and biocides), highlighting any priority substances
- identifying the effluent and surface water run-off streams contributing to the overall discharge and how they are controlled
- potential options and associated environmental impact for disposal for each effluent stream
- the means of control in the event of detection of unplanned radioactive or other contamination of the discharge

The submission does, however, include a commitment that these aspects will be covered in a later stage of the GDA process.

The submission includes a list of possible ways that waste heat could be recovered, but defers any further consideration to a later stage of the GDA process.

GNS have excluded the impact of thermal discharges from the scope of GDA, stating that this will be addressed at the site-specific stage.

GNS had not received any comments on discharges to surface waters by 31 August 2018.

Our conclusion, at the principle level, is that not enough information has been provided to determine whether the environmental impact of the proposed discharges of non-radioactive contaminants, including heat, to surface waters at a site within the generic site constraints will be acceptable.

For our detailed assessment, we will need further information as set out in item 9.1 to 9.6 of Annexe 2.

5.4.3. Discharges to groundwater

The submission confirms in chapter 26.4.3 of the Preliminary Safety Report (PSR) (document reference HPR/GDA/PSR/0026) that there are no discharges to groundwater.

5.4.4. Operation of installations (combustion plant and incinerators)

Most nuclear power plant designs include conventional combustion plant for standby generation and/or use as auxiliary boilers. Above a certain capacity, operating this type of plant will require an environmental permit and a greenhouse gas emissions permit from the Environment Agency. We ask the Requesting Party to specify the combustion plant that is required and if:

the aggregate rated thermal input of all combustion plant is greater than 50 Megawatt (thermal) (MW_{th}) to compare the proposed technology against our sector guidance (Environment Agency, 2009)

- the aggregate thermal input is greater than 20 MW_{th}, to describe how greenhouse gas emissions will be monitored

The submission describes the combustion plant in chapter 26.4.4 of the Preliminary Safety Report (PSR) (document reference HPR/GDA/PSR/0026).

The submission states that the UK HPR1000 design will include the following combustion plant:

- 3 emergency diesel generators each with a rated output of 8 MW_{th}
- 2 fixed station black out diesel generators each with a rated output of 3.5 MW_{th}

The threshold in the legislation is based on rated thermal input, and the submission states that the Requesting Party currently anticipates that the aggregated thermal input will be in excess of the 50 MW_{th} threshold. An environmental permit will, therefore, be required. The Requesting Party has not yet compared the proposed technology against our sector guidance, but the submission does contain a commitment that it will do this at a later stage of this GDA process.

The combustion plant will be subject to the Medium Combustion Plant Directive (MCPD) and no reference is made to the requirements of this Directive in this submission.

Greenhouse gases will need to be monitored because the design exceeds the 20 MW_{th} threshold. The submission includes a commitment to use the ‘standard methodology’ from ‘MRR - General Guidance for Installations’ for monitoring greenhouse gas emissions. This is a valid approach, but further information will be needed on how this will be implemented.

An EPR16 permit might also be needed for any on-site waste incinerator. However, the submission confirms in Chapter 26.4.4 of the Preliminary Safety Report (PSR) (document reference HPR/GDA/PSR/0026) that the design does not include an on-site incinerator.

GNS had not received any comments on the combustion plant by 31 August 2018.

Our conclusions, at the principle level, are:

- the proposed combustion plant would require a permit from the Environment Agency under EPR16
- not enough information has been provided to determine whether the proposed technology is consistent with our sector guidance
- the proposed combustion plant would require a greenhouse gas emissions permit
- the proposals for monitoring greenhouse gas emissions are acceptable in principle, as a valid methodology will be applied, but further detail will be needed

For our detailed assessment, we will need further information as set out in items 11.1 to 11.4 of Annexe 2.

5.4.5. Substances subject to the Control of Major Accident Hazards Regulations

We ask the Requesting Party to identify any need for the on-site storage of ‘dangerous substances’ above the qualifying thresholds in COMAH15 and, if a threshold is exceeded, to describe the measures taken in the design to prevent a major accident to the environment.

The submission discusses dangerous substances in chapter 26.4.5 of the Preliminary Safety Report (PSR) (document reference HPR/GDA/PSR/0026) and chapter 25.6.3 of the PSR (document reference HPR/GDA/PSR/0025).

The submission provides an overview of the COMAH15 requirements, but explains that not enough information on the types and quantities of dangerous substances is available at this time. The submission contains a commitment that applicability of COMAH15 will be addressed at a later stage of the GDA process.

GNS had not received any comments on substances subject to COMAH Regulations by 31 August 2018.

Our conclusion, at the principle level, is that not enough information has been provided to determine whether COMAH15 applies to the design.

For our detailed assessment, we will need further information as set out in items 12.1 and 12.2 of Annexe 2.

5.4.6. Fluorinated greenhouse gases and ozone-depleting substances

We ask the Requesting Party to identify any equipment included in the design that will contain fluorinated greenhouse gases or ozone-depleting substances and describe the measures taken in the design to prevent and minimise leakage of these substances.

The submission discusses fluorinated greenhouse gases and ozone-depleting substances in chapter 26.4.6 of the Preliminary Safety Report (PSR) (document reference HPR/GDA/PSR/0026).

The submission states that fluorinated greenhouse gases are likely to be used in the design as refrigerants (air conditioning, fire suppression) but no further detail is provided. The submission contains a commitment that the use of these substances will be addressed at a later stage in the GDA process.

GNS had not received any comments on fluorinated greenhouse gases or ozone-depleting substances by 31 August 2018.

Our conclusion, at the principle level, is that not enough information has been provided to determine whether equipment containing fluorinated greenhouse gases or ozone-depleting substances will be managed to prevent and minimise leakage of these substances.

For our detailed assessment, we will need further information as set out in items 13.1 and 13.2 of Annexe 2.

6. Overall conclusions of our initial assessment

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 this initial assessment stage and based only on information we have seen to date, our conclusions are:

- we did not find any matters within the submission that are obviously unacceptable
- we have not identified any significant design modifications that are likely to be needed before we could issue a permit
- GNS 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 GNS, 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 have at present, it is unlikely that radioactive discharges would exceed those of comparable power stations, but the Requesting Party need to demonstrate this for discharges and for quantities of solid waste
- the submission does not contain the level of information that we need in order to carry out a detailed assessment

These conclusions are based on our initial assessment of the PSR submission and ongoing technical discussions. We may develop further or modified conclusions once GNS has provided all the required information and we have carried out our detailed assessment.

6.1. Further information

Our information requirements are set out in our P&ID (Environment Agency, 2016). The submission does not fully address a number of these requirements and further information is needed so we can carry out our detailed assessment. GNS has verbally committed to provide each item of information specified in Annexe 2.

As a result of this commitment, we have deliberately delayed issuing many RQs and any ROs or RIs where there are currently obvious deficiencies. This was to allow GNS to progress with the work. However, if the necessary information is not in the next submission, or the submission does not identify information gaps and include details of what will be provided to close that gap, we will be following these up with RQs, RO or RIs where appropriate.

Subject to the quality of the information provided and an appropriate timetable for providing the outstanding information, yet to be agreed, this will allow us to proceed to public consultation in late 2020. This is consistent with achieving the 4-year timeframe (from receipt of initial submission) for completing GDA.

7. References

Reference	Author / Publication / Website
Environment Agency, 2006a	Initial radiological assessment methodology – part 1 user report (Science Report SC030162/SR1, Environment Agency, May 2006). https://www.gov.uk/government/publications/initial-radiological-assessment-methodology
Environment Agency, 2006b	Initial radiological assessment methodology – part 2 methods and input data (Science Report SC030162/SR2, Environment Agency, May 2006). https://www.gov.uk/government/publications/initial-radiological-assessment-methodology
Environment Agency, 2009	How to comply with your environmental permit, Additional guidance for: Combustion Activities (EPR 1.01). https://www.gov.uk/government/publications/combustion-activities-additional-guidance
Environment Agency, 2010a	Regulatory Guidance Series, No RSR 1. Radioactive Substances Regulation – Environmental Principles. Version 2, April 2010. https://www.gov.uk/government/publications/radioactive-substances-regulation-environmental-principles
Environment Agency, 2010b	RSR: Principles of optimisation in the management and disposal of radioactive waste. Version 2, April 2010. https://www.gov.uk/government/publications/rsr-principles-of-optimisation
Environment Agency, 2012	Criteria for setting limits on the discharge of radioactive waste from nuclear sites. Version 1, June 2012. https://www.gov.uk/government/publications/discharge-of-radioactive-waste-from-nuclear-sites-setting-limits
Environment Agency, 2015	Impact Assessment of ionising radiation on Wildlife. R&D publication 128 Version 2 as revised by SKN_CEN 2015.
Environment Agency, 2016	Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs. Version 3, October 2016. https://www.gov.uk/government/publications/assessment-of-candidate-nuclear-power-plant-designs
Environment Agency, 2017	TGN M1 Sampling requirements for stack emission monitoring version 8, August 2017. LIT 4736. https://www.gov.uk/government/publications/m1-sampling-requirements-for-stack-emission-monitoring
Environment Agency, Food Standards Agency, Northern Ireland Environment Agency and Scottish Environment Protection Agency, 2017	Radioactivity in food and the environment, 2016: RIFE 22. https://www.gov.uk/government/publications/radioactivity-in-food-and-the-environment-rife-reports-2004-to-2016

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UK Parliament, 2016	United Kingdom. Parliament. House of Commons. Statutory Instrument 2016 No. 1154. The Environmental Permitting (England and Wales) Regulations 2016. London: The Stationery Office. http://www.legislation.gov.uk/uksi/2016/1154/made
UK Parliament, 2011a	United Kingdom. Parliament. House of Commons. Department of Energy and Climate Change, 2011. National Policy Statement for Nuclear Power Generation (EN-6). London: The Stationery Office. https://www.gov.uk/consents-and-planning-applications-for-national-energy-infrastructure-projects
UK Parliament, 2011b	United Kingdom. Parliament. House of Commons. Department of Energy and Climate Change, 2011. Funded decommissioning programme guidance for new nuclear power stations. London: The Stationery Office. https://www.gov.uk/government/consultations/revised-funded-decommissioning-programme-guidance-for-new-nuclear-power-stations
UK Parliament, 2008	United Kingdom. Parliament. House of Commons. Department for Business Enterprise and Regulatory Reform, 2008. Meeting the Energy Challenge - A White Paper on Nuclear Power. London: The Stationery Office. http://webarchive.nationalarchives.gov.uk/20100512172052/http:/www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/white_paper_08/white_paper_08.aspx

8. List of abbreviations

Acronym	Definition
ACPR1000	Advanced Chinese Pressurised water Reactor
ALARP	As low as reasonably practicable
BAT	Best available techniques
CGN	Chinese General Nuclear Corporation
COMAH15	The Control of Major Accident Hazards Regulations (COMAH) 2015
CPR1000	Chinese Pressurised water Reactor
Defra	Department for Environment, Food & Rural Affairs
EA95	The Environment Act 1995
EDF	Électricité de France
EMCL	Environmental Media Concentration Limits
EPR16	The Environmental Permitting (England and Wales) Regulations 2016
EU	European Union
FCG-3	Fangchenggang unit 3
GDA	Generic design assessment
GDF	Geological disposal facility
GNS	General Nuclear Systems Limited
GWTS	Gaseous waste treatment system
HAW	High activity waste
HEPA	High efficiency particulate air (filter)
HLW	High level waste
HPR1000	Hualong One Pressurised Reactor (used when referring to the reference plant Fangchenggang unit 3)
HVAC	Heating ventilation and air-conditioning
IAEA	International Atomic Energy Agency
ILW	Intermediate level waste
IRAT	Initial Radiological Assessment Tool
iSoDA	Interim Statement of Design Acceptability
ISO	International Standards Organisation
JPO	Joint Programme Office
LLW	Low level waste
LLWR	Low Level Waste Repository
MCPD	Medium Combustion Plant Directive
MSQA	Management systems and quality assurance
MW	Megawatt

MW_{th}	Megawatt (thermal)
MWd/tU	Megawatt days per tonne of uranium
ONR	Office for Nuclear Regulation
OPEX	Operational experience
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic (referred to as the Oslo-Paris Convention)
P&ID	Process and Information Document
PSR	Preliminary Safety Report
PWR	Pressurised water reactor
REPs	Radioactive Substances Regulation Environmental Principles
RI	Regulatory Issue
RO	Regulatory Observation
RP	Requesting Party
RQ	Regulatory Query
RSR	Radioactive Substances Regulation
RWM	Radioactive Waste Management Limited
SFIS	Spent fuel interim storage facility
SFP	Spent fuel pond
SoDA	Statement of Design Acceptability
SWTS	Solid waste treatment system
UK	United Kingdom
UK HPR1000	The version of the HPR1000 to be deployed in the UK
VLLW	Very low level waste
WMH	Waste management hierarchy
WRA91	The Water Resources Act 1991

Annexe 1- Documents considered during initial assessment

Document Title	GNS Document No.	Revision
Preliminary Safety Report		
Chapter 1 - Introduction	HPR/GDA/PSR/0001	Rev 000
Chapter 2 - General Plant Description	HPR/GDA/PSR/0002	Rev 000
Chapter 3 - Generic Site Characteristics	HPR/GDA/PSR/0003	Rev 000
Chapter 4 - General Safety and Design Principles	HPR/GDA/PSR/0004	Rev 000
Chapter 5 - Reactor Design Parameters	HPR/GDA/PSR/0005	Rev 000
Chapter 10 - Auxiliary Systems	HPR/GDA/PSR/0010	Rev 000
Chapter 20 - MSQA & Safety Case Management	HPR/GDA/PSR/0020	Rev 000
Chapter 21 - Reactor Chemistry	HPR/GDA/PSR/0021	Rev 000
Chapter 22 - Radiological Protection	HPR/GDA/PSR/0022	Rev 000
Chapter 23 - Radioactive Waste Management & Fuel Storage	HPR/GDA/PSR/0023	Rev 000
Chapter 24 - Decommissioning	HPR/GDA/PSR/0024	Rev 000
Chapter 26 - Environment	HPR/GDA/PSR/0026	Rev 000
Supporting Information		
UK HPR1000 Generic Site Report	HPR/GDA/REPO/0015	Rev 000
Requirements on optioneering and decision making	HPR-GDA-PRC-0012	Rev 000
ALARP & BAT - Principles and requirements	HPR-GDA-PRC-0089	Rev 000
Scope for UK HPR1000 GDA Project	HPR-GDA-REPO-0007	Rev 000

Annexe 2 - Further information required for detailed assessment

Information required	Agreed provision date
1 Management system **None identified.**	
2 Generic site and dose assessment **2.1 Generic site. We have noted that some additional information will be needed related to the environmental part of the generic site, which links to and joins up with the dose assessment for public and wildlife. The additional information should include the assumed area/size of the site; the nature and shape of the coast (estuary or open coastline); the likely position of the site on the coast; the type of terrestrial environment around the site (urban, rural or agricultural); the assumed position of the gaseous discharges point on the site and the assumed marine environment into which liquid discharges and cooling water discharges occur - enclosed estuary or open coastal environment.** **A simplified schematic outline of the generic site would be helpful.** **During our visit to China in March 2017, we noted that CGN may be unfamiliar with the relatively small sizes of sites in the UK. Daya Bay (Shenzhen, China) for example, is a large site compared with most nuclear power station sites in the UK. In the UK, receptor points can be close to the site, for example at 50 m or 100 m from the boundary or release point.** **2.2 Dose assessment. It will be appropriate for the Requesting Party to provide a complete assessment of doses to the public. In the submissions seen so far, the dose assessment uses the Initial Radiological Assessment Tool provided by the Environment Agency (IRAT). The IRAT provides an initial assessment. The modelling arrangements in IRAT is fixed and relatively inflexible. The Requesting Party should justify the model and declare any limitations of the application of the IRAT model to the generic site. The Requesting Party should also identify any aspects of the IRAT system that may be out of date, such as the underpinning IAEA data and the dispersion models such as PC-CREAM. The implications of updating the IAEA data and the models should be considered. For a stage 3 - detailed assessment the Requesting Party should provide a clear description and justification of the method and data used.** **The Requesting Party needs to provide a clear description and justification of the method and data used for assessing short duration releases.** **The Requesting Party needs to carry out further work on the direct dose assessment, making sure it is appropriate for meeting both Environment Agency and ONR requirements.** **Environmental accumulation/build up. Where the results of the environmental build/accumulation are presented, it would be helpful if**	For detailed assessment

the results showed the build-up over time in the main environmental media over 60 years from the start for each radionuclide in the discharges. This could be in the form of a time trend graph. This information will indicate whether any of the radionuclides reach equilibrium in the environment within the 60 years of the start of the discharge. **2.3 Respond to any further RQs** **2.4 A justification for using ERICA for non-human species assessment** **2.5 A justification for selecting R&D128 for non-human species assessment of noble gases impact**	
3 Radioactive waste management – strategic considerations **3.1 Develop an integrated waste strategy, or radioactive waste management strategy that sets out how the UK strategic considerations have been considered in the UK HPR1000 design.**	For detailed assessment
4 Radioactive waste arisings and proposals for management and disposal **4.1 Provide information regarding generating problematic waste during reactor lifecycle** **4.2 Provide information on the volume, activity and composition of waste generated during operation and decommissioning of the reactor** **4.3 Provide information on the option selection and arrangements for interim storage of solid waste** **4.4 Provide information on optimising solid waste disposal, including identifying boundary wastes** **4.5 Provide information on engaging with waste disposal operators about disposability of waste and spent fuel** **4.6 Provide information on the estimated number of fuel assemblies that will be produced over the lifecycle of the reactor** **4.7 Provide information on the proposed conditioning and packaging of spent fuel**	For detailed assessment
5 Protection of people and the environment (BAT) **5.1 Provide detailed information on proposed radioactive waste management systems** **5.2 Define a systematic approach for demonstrating BAT** **5.3 Demonstrate that BAT is influencing the reference design (HPR1000) for deployment in the UK (UK HPR1000)** **5.4 Demonstrate that the priorities for improvements are related to public dose impact or non-human species dose rate impact** **5.5 identify and present the necessary evidence to support the BAT claims and arguments** **5.6 Consider both technique and the implementation of the selected technique**	For detailed assessment

6 Quantification and assessment of radioactive waste disposals **6.1 Robust evidence on which the estimated annual discharges of aqueous and gaseous radioactive waste from the UK HPR1000 have been based** **6.2 Methodology for determination of events are likely to occur over the lifetime of the plant and evidence that they are included in the derivation of the discharge estimates** **6.3 A statistical analysis of the evidence on which the estimated monthly discharges of aqueous and gaseous radioactive waste from the UK HPR1000 have been based** **6.4 A derivation of a statistical method to define proposed discharge limits based on estimated monthly discharges of aqueous and gaseous radioactive waste for the UK HPR1000** **6.5 A comparison of discharges with comparable plants on a worldwide basis** **6.6 Quantitative information on likely solid waste and spent fuel disposals**	For detailed assessment
7 Measurement of radioactive waste discharges and disposals **7.1 Details of in-process monitoring arrangements** **7.2 Details of the arrangements for monitoring solid waste and non-aqueous waste** **7.3 A demonstration, for gaseous discharge monitoring, that the particle penetration factors required by international standards are met** **7.4 Details on a stack sampling platform and spare port** **7.5 Monitoring arrangements for key radionuclides specified in EU Commission recommendation 2004/2/Euratom not addressed to date (strontiun-90 and total alpha) and confirmation that sensitivity is sufficient to:** • **readily demonstrate compliance with the proposed limits** • **meet the levels of detection specified in EU Commission Recommendation 2004/2/Euratom**	For detailed assessment
8 Water use and abstraction **8.1 Freshwater use - Provide estimated quantities of freshwater that will be used for each proposed use and for the site as a whole** **8.2 Cooling water - Provide a detailed assessment and conclusion on the method to be used for cooling water before being discharged back to sea** **8.3 Cooling water - Provide detail on the proposed quantities of cooling water to be used in each part of the design and for the site as a whole** **8.4 Fish deterrent and return schemes - Provide a detailed review of options available. Requirement and selection is a site specific matter.**	For detailed assessment
9 Discharges to surface waters	For detailed assessment

9.1 Provide information on sources and quantities of contaminants, including disinfectant and biocides, highlighting any priority substances (as specified in the 'Priority Substances' Directive 2008) **9.2 Identify individual effluent and surface water run-off streams contributing to the overall discharge and how they are controlled** **9.3 Provide information on potential options and associated environmental impact for disposal of each individual effluent stream** **9.4 Provide details on the means of control in the event of detection of unplanned radioactive or other contamination of the discharge** **9.5 Provide the outcomes from the proposed further considerations of how waste heat can be used beneficially** **9.6 Provide greater detail on how the environmental impact of thermal discharges can be addressed for the generic site**	
10 Discharges to groundwater **10.1 No further information required at this time**	
11 Installations (combustion plant) **11.1 Provide a comparison of the proposed combustion plant technology against the sector guidance in order to demonstrate BAT** **11.2 Describe how the greenhouse gas monitoring guidance will be implemented in this design** **11.3 Provide an environmental impact assessment (for example, H1) for the potential emissions to air from the combustion plant** **11.4 Provide an assessment of how the Medium Combustion Plant Directive may apply to the design**	For detailed assessment
12 COMAH substances **12.1 Provide details of the maximum quantities of any dangerous substances that will be stored on site, at all stages of the lifecycle of the facility, and provide a comparison against the COMAH15 qualifying thresholds** **12.2 Where a COMAH 15 threshold is exceeded, describe the measures taken to prevent a major accident to the environment**	For detailed assessment
13 Fluorinated greenhouse gases and ozone-depleting substances **13.1 Provide information on any equipment that will contain fluorinated greenhouse gases or ozone-depleting substances** **13.2 Where these substances are present in equipment, describe the measures taken to prevent and minimise leakage of these substances**	For detailed assessment

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