Preliminary detailed assessment of other environmental regulations for General Nuclear System Limited's UK HPR1000 design - AR08

Version 1, 11 January 2021

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Executive summary

This report covers our Generic Design Assessment (GDA) of General Nuclear System Limited's (GNSL's) submission on information relating to other environmental regulations for the United Kingdom Hualong Pressurised Reactor (UK HPR1000) design as required in Table 1, Item 8 of our Process and Information Document (P&ID) (Environment Agency, 2016).

In the GDA process regulatory effort is focused primarily on matters relating to the generation and disposal of radioactive waste and its impact on the environment. Additionally, there are number of other important environmental regulatory requirements that may also apply to the construction, operation and decommissioning of a nuclear power plant. Those where the Environment Agency has a regulatory role include:

- water use and abstraction – nuclear power plants require significant volumes of water for use in the process and for cooling, and an abstraction licence may be required
- discharges to surface waters – nuclear power plants produce non-radioactive liquid waste streams, including waste heat, which require an environmental permit to discharge to surface water
- discharges to groundwater – any discharges to groundwater need an environmental permit
- operation of installations – nuclear power plants require back-up power (for example, diesel generators) in the case of loss of off-site power. Any combustion plant used may need an environmental permit and a greenhouse gas permit. Any incineration of waste on site may also need an environmental permit
- substances subject to the Control of Major Accident Hazards (COMAH) Regulations – nuclear power plants typically use substances classed as dangerous under the regulations, such as diesel oil or hydrazine, and may be subject to COMAH regulations depending on the amount of such substances stored on site
- fluorinated greenhouse gases and ozone-depleting substances - legal requirements are placed on the operator of a site where these types of substances are used

GNSL presented information covering these areas in its ‘Conventional Impact Assessment' (GNSL, 2020b) following the requirements in Section 8 of Table 1 of our Process and Information Document (P&ID) (Environment Agency, 2016).

There are certain aspects of the UK HPR1000 cooling water design that can only be specified at the site-specific stage. These include the abstraction intakes and fish deterrent and return schemes.

It has been agreed that the assessment of the thermal impact of discharges to surface waters will be out of scope of GDA as this requires information on the behaviour of the receiving surface water.

Our main preliminary conclusions for each of the topic areas covered in our assessment in relation to our future regulation of the UK HPR1000 are:

- an abstraction licence would not be required if cooling water is abstracted from open coastal waters, but it is likely to be required if an estuary location is chosen
- the discharge of non-radioactive liquid waste will require an environmental permit for a water discharge activity. However, any future operator will need to provide more detailed information on the aqueous waste streams and demonstrate that the

environmental impact from the discharges is acceptable at the site-specific permitting stage

- there are no direct or indirect discharges to groundwater based on the generic design, therefore, an environmental permit is not required. The pollution prevention techniques specified in the design should prevent contamination of groundwater. If any of the generic design assumptions change at a site-specific stage, then this preliminary conclusion will need to be reconsidered
- the combustion plant proposed to be used (diesel generators) would require an environmental permit for an installation activity. A future operator will need to provide a best available techniques (BAT) case for the specific design of the generators selected for use, demonstrate that the combustion plant would comply with emission limit values for certain substances that we determine to be necessary and that the impact on people and the environment from the emissions is likely to be acceptable
- the UK HPR1000 has been assessed not to fall under the COMAH Regulations during its commissioning or operational phases. If any of the generic design assumptions change at a site-specific stage, then this preliminary conclusion will need to be reconsidered
- no ozone-depleting substances are proposed to be used in the design
- the proposed quantities of specific fluorinated greenhouse gases to be used in the design are currently acceptable under the relevant legislation and in common with current UK practice. The level of detail in the proposed measures to prevent and minimise leakage is considered acceptable for GDA

We have not identified any GDA Issues.

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

Assessment Fining 32: A future operator shall engage with the local water supply company early in the site-specific stage. This is to ensure that sufficient quantities of fresh water can be supplied to meet the requirements of the UK HPR1000 or to determine whether an alternative source of fresh water will need to be identified.

Assessment Finding 33: A future operator shall ensure that the siting of the cooling water intake and outlets are BAT for the UK HPR1000 design at each specific site.

Assessment Finding 34: A future operator shall review the calculations for emissions of chemicals as part of the site-specific environmental risk assessment. Particular attention should be focussed on the application of possible treatment techniques for hydrazine to reduce the amount discharged to the environment, and therefore minimise any impact.

Assessment Finding 35: A future operator shall ensure that the storage, treatment and monitoring systems for the 3 non-radioactive effluent streams provide the appropriate level of environmental protection for the receiving environment in terms of quality of effluent discharged. This would be regulated by a water discharge activity permit.

Assessment Finding 36: A future operator shall provide in an application for a water discharge activity environmental permit a site-specific environmental impact assessment for discharges to water. The modelling shall use site-specific parameters based on the environmental setting and the specific chemicals selected for use.

Assessment Finding 37: A future operator shall provide in an application for an environmental permit a BAT assessment of the specific combustion plant selected for use against the relevant BAT guidance at the time of application.

Assessment Finding 38: A future operator shall provide in an application for a combustion activity environmental permit a site-specific environmental impact assessment for discharges to air. The modelling shall use site-specific parameters based on the environmental setting and the specific combustion plant selected for use.

Assessment Finding 39: Based on the information presented at GDA, the UK HPR1000 will not be a COMAH establishment during commissioning or operational phases. A future operator shall keep the proposed chemical inventories under review so any applicability of COMAH can be identified early and the necessary major accident prevention measures can be installed.

Assessment Finding 40: A future operator shall keep the fluorinated greenhouse gases proposed for use in the UK HPR1000 under review to ensure they continue to be legally acceptable for use.

Contents

1. Introduction

This report provides our detailed assessment of GNSL's submission in relation to other environmental regulations in the UK HPR1000 design for GDA purposes.

This report is based on information received up to and including 30 June 2020. Any subsequent or updated information will be assessed alongside the responses to our consultation. Our final assessment results will be published in our Decision Document at the end of GDA. We are targeting completing GDA in early 2022.

We use a 2-stage process to carry out GDA: initial assessment, followed by detailed assessment. The findings from our initial assessment are set out in the Initial assessment: Statement of findings published in November 2018.

This detailed assessment has built on that initial assessment and is based on additional submissions and ongoing technical engagement with GNSL (the Requesting Party (RP)). The assessment method, findings and preliminary conclusions are presented in this 'preliminary detailed assessment report'.

Our GDA process focuses primarily on matters relevant to the disposal of radioactive waste. In addition to the regulations covering the generation and disposal of radioactive waste, there are a number of other environmental regulations that apply to a nuclear power plant. The GDA process needs to ensure that the requirements of these regulations have been considered by the Requesting Party in its design.

Our Process & Information Document (P&ID), (Environment Agency, 2016) sets out the information we require on other environmental regulations as follows:

- water use and abstraction
- discharges to surface waters
- discharges to groundwater
- operation of installations (combustion and incineration)
- Control of Major Accident Hazards (COMAH) Regulations
- fluorinated greenhouse gases and ozone depleting substances

Each of the above topic areas are covered within the Requesting Party (RP) General Nuclear System Limited's (GNSL) ‘Conventional Impact Assessment’ submission (GNSL, 2020b).

We set up an agreement with GNSL to carry out a GDA of the UK HPR1000 design, which came into effect in January 2017. Following this agreement, GNSL submitted to us, for assessment, Revision 000-1 of the ‘Pre-Construction Environmental Report (PCER) Chapter 8 - Conventional Impact Assessment v0’ (GNSL, 2018). A table listing the GNSL documentation assessed is provided in Appendix 1. Our assessment of this submission and the supporting documents generated a number of Regulatory Queries (RQs). A table summarising these and later RQs is provided in Appendix 2. Subsequent responses to these RQs and discussions at meetings with the Requesting Party (RP) have been incorporated into the latest revision of the ‘Conventional Impact Assessment' submission (GNSL, 2020b).

2. Assessment

2.1. Assessment method and process

This assessment covers GNSL's 'Conventional Impact Assessment' submission (GNSL, 2020b). This submission covered a number of different topic areas that are relevant to the operation of the UK HPR1000.

Our approach to the assessment was to:

- consider the submissions for the 'other environmental regulations' topic areas made by GNSL
- hold technical meetings with GNSL (the RP) to clarify and improve our understanding of the information presented and to identify and explain any concerns we had with that information
- raise Regulatory Issues (RIs), Regulatory Observations (ROs) or Regulatory Queries (RQs) where we believed GNSL did not provide enough information
- assess the RP's GDA submission using relevant guidance, legislation and regulatory experience
- decide on any potential GDA Issues (GDAI) or Assessment Findings (AF) to carry forward from GDA

Our and ONR's detailed assessment process will continue through and beyond the period of Environment Agency public consultation, and consequently our work on this topic is ongoing.

2.2. Assessment limitations and scope

The 6 topic areas covered in the 'other environmental regulations' assessment are very site-specific by their nature. Each of them will require further work at the site-specific stage when the receiving environment is known and the detailed design has advanced further. The assessment during GDA is intended to ensure the RP has understood and captured the main legislative requirements that the UK HPR1000 will have to meet and that these requirements are considered in the design. The scope of the GDA assessment was to develop the submissions as far as is reasonable for a generic site setting and conclude with what will be the likely starting point for site-specific work in the form of final conclusions and Assessment Findings. This approach is followed for each of the 6 topic area assessments discussed below.

3. Water use and abstraction

The supply of water is limited so we ensure it is managed and used in a way that meets the needs of people and the natural environment. We do this through an abstraction licensing system. Any person who abstracts more than 20 m^3 a day from inland waters requires an abstraction licence from us. Further information can be found on the GOV.UK website at www.gov.uk/guidance/water-management-abstract-or-impound-water#local-water-availability.

3.1. Assessment objectives

Our assessment for this topic area was aimed at:

- understanding the requirements for water use in the UK HPR1000
- identifying the potential sources of water to be used
- deciding whether any licences or permits might be required for water abstraction
- deciding whether the choice of cooling option(s) proposed for the generic site was appropriate
- identifying any issues connected with water use

3.2. Assessment

3.2.1. Regulatory context

In its submission, the RP demonstrated a good understanding of the legislation relating to water use and abstraction.

3.2.2. Assumptions

The RP made the following assumptions in relation to water use and abstraction:

- Fresh water (for example, process and drinking water) will be provided by a water supply company, therefore an abstraction licence would not be required.
- Water for cooling the turbine condenser and other plant systems will need to be abstracted from the environment. Once-through sea water cooling is considered to be the most appropriate environmental option for a coastal or estuary site.
- Biocide dosing strategy necessary for a sea water based turbine condenser cooling system is a site-specific decision. However, for the purposes of GDA, sodium hypochlorite has been assumed for the water discharge impact assessment.

We consider the assumptions to be reasonable at the GDA stage for a generic site. Any changes to these assumptions are likely to affect our assessment outcomes.

3.2.3. Fresh water requirements

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

Assessment Fining 32: A future operator shall engage with the local water supply company early in the site-specific stage. This is to ensure that sufficient quantities of fresh water can be supplied to meet the requirements of the UK HPR1000 or to determine whether an alternative source of fresh water will need to be identified.

In terms of the fresh water usage requirements of the design, the RP has outlined 3 main areas:

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

These estimated consumption figures are based on the operation of one unit. They are underpinned by a full breakdown, with calculations, of fresh water use in the supporting document 'Fresh Water Requirements Calculation' (GNSL 2019a).

We raised RQ-UKHPR1000-0824 to seek clarification on a number of points relating to the detailed calculations presented in the 'Fresh Water Requirements Calculation' document (GNSL, 2019a). Our queries were generally related to where particular numbers used in the usage calculations came from. In its response, GNSL satisfactorily explained the calculations more fully, and we are now content with the conclusions.

By taking into account several factors, such as the expected plant availability and daily variations in usage, the RP has concluded that the total annual fresh water consumption will be approximately 405,835m^3 a year. This level of consumption is broadly similar to similar types of power plants.

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

3.2.4. Cooling water system requirements

GNSL states that the generic site being considered for GDA is a coastal or estuary site (GNSL, 2020c). An abstraction licence would not be required if cooling water is abstracted from open coastal waters, but it is likely to be required if an estuary location is chosen.

Cooling water is essential in 3 aspects of the UK HPR1000 design:

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

Inevitably, the 3 cooling water systems will discharge water at a higher temperature than it was abstracted at. The following table describes the quantity and temperature rise information GNSL provided for each system.

Table 2: GNSL information on cooling water usage during normal operation

Cooling water system	Cooling water demand (m3/h) Minimum during outage	Cooling water demand (m3/h) Normal operation	Temperature rise (ºC)
Circulating water system	0	187,200	Approx. 10
Essential service water system	2,700	3,600	Approx. 7.3
Auxiliary cooling water system	--	72,000	Approx. 3.5

Cooling water system	Cooling water demand (m3/h) Minimum during outage	Cooling water demand (m3/h) Normal operation	Temperature rise (ºC)
Total	**2,700**	**198,000**	**Approx. 9.7 when the three system effluents are combined**

Note on Table 2: As the designers propose a once-through cooling approach, the volume discharged provides an indication of the volume that will be abstracted and used in the processes.

All 3 systems flow to the seal pit and are mixed before being discharged, therefore, including a 'total' temperature rise is considered appropriate. The seal pit is a structure designed to prevent air getting back into the cooling water and effluent systems and is linked to the main site outfall into the environment.

The quantity and temperature rise figures GNSL presented are similar to other reactor designs that have been subject to the GDA process and to existing operational nuclear power plants in the UK.

GNSL concludes that it considers a once-through cooling system to be the most appropriate environmental option for the UK HPR1000 design. This conclusion is based on information in our 2010 publication ‘Cooling water options for the new generation of nuclear power stations’ (Environment Agency, 2010). The report concludes that direct (once-through) cooling ‘can be the most appropriate environmental option for large power stations sited on the coast or estuaries, subject to current best planning, design and operational practice and best available mitigations being put in place, and meeting conservation objectives of the site in question.’

GNSL has also made reference to the European Commission’s ‘Best Available Techniques Reference (BREF) Document on Industrial Cooling Systems’ (EU, 2001), and states that a once-through cooling system can be considered BAT for a coastal location. The BREF document also states that rivers and estuaries may be acceptable for processes requiring large cooling capacities if the extension of the heat plume in the surface water leaves passage for fish migration, the intake is designed to reduce fish entrainment, and the heat load doesn't affect other users of the receiving water. A future operator should use the BREF document and all guidance available at the time of each site-specific stage to establish whether the design is BAT for that location. We consider the following Assessment Finding to be appropriate to ensure that site-specific decision making on cooling water options considers BAT:

Assessment Finding 33: A future operator shall ensure that the siting of the cooling water intake and outlets are BAT for the UK HPR1000 design at each specific site.

Based on the conclusions from the BREF document and our cooling water options report, we accept, for the purposes of GDA, that once-through cooling water could be considered suitable for the UK HPR1000 design at a coastal or estuary location.

Despite presenting a case for a once-through cooling water system at GDA, the RP is also clear that other options are available for consideration at the site-specific stage depending on site-specific characteristics (including ecology and biodiversity). Other options presented for future consideration are:

- once-through system with cooling towers
- recirculating system using natural draft cooling towers

- recirculation system using mechanical draft cooling towers
- open or closed hybrid cooling system with hybrid cooling towers

All of the above systems are covered in some detail in our 2010 publication ‘Cooling water options for the new generation of nuclear power stations’ (Environment Agency, 2010). Any of the above have the potential to be considered BAT based on site-specific characteristics, so are available for a future operator to consider.

3.2.5. Fish deterrent and recovery and return systems

GNSL states that the cooling water intake needs to be located and designed to minimise the impact on surrounding habitats and marine organisms, in particular fish. GNSL considers that fish deterrent and recovery and return systems are highly site-specific due to the complex combination of factors that need to be taken into account (for example, intake capacity, nature of the water body, climatic condition, local flora and fauna and the physiology of the fish present). GDA can therefore only consider the options that are available and then highlight the aspects that need to be considered by a future operator at the site-specific permitting stage. No site-specific options are ruled out at GDA stage.

GNSL proposes that the following aspects will need to be considered:

- location of intake structure - with particular attention on habitats and impact on fish species present
- design of the intake structure - intake velocities should be sufficient for the power plant’s needs while being low enough to allow fish and other aquatic organisms to escape entrainment, impingement and entrapment. An additional consideration for the intake design is to minimise entrainment of sediment in the water drawn into the plant
- use of screens and fish return systems - GNSL states that the UK HPR1000 design can accommodate various screening systems that incorporate a coarse and fine rack system to minimise fish and debris entering the cooling water systems as well as a fish return system
- use of physical barriers - physical barriers include barrier nets, microfiltration barriers and bar screens. Any debris clearing methods used at the coarse rack should consider the protection of fish
- use of behavioural barriers - options for the UK HPR1000 include bubble curtains, electrical barriers, acoustic fish deterrents, artificial lighting or a combination of these

GNSL concludes that the above aspects are site-specific considerations when the local environmental setting and species present are known. We agree with this conclusion at the GDA stage.

In preparing this part of its submission, GNSL has referred to our published guidance 'Screening for intake and outfalls: a best practice guide' (Environment Agency, 2005). This will need to be considered in greater detail at the site-specific stage by a future operator.

At the time of writing, an additional Environment Agency guidance document had recently been published (April 2020) 'Nuclear power station cooling waters: protecting biota' (Environment Agency, 2020a). This new guidance has not been considered during GDA, and will need to be considered in detail at the site-specific stage by a future operator.

3.2.6. Eels Regulations

Operators abstracting more than 20 m^3/day of water or discharging water back to any channel, bed or sea are subject to the requirements of The Eels (England and Wales)

Regulations 2009 (GB Parliament, 2009) and must screen the abstraction/discharge to prevent the entrapment of eels, unless an exemption notice has been granted.

GNSL states that the Eels Regulations requirements will be considered in the site-specific design of the intake location, intake structures, fish return systems and physical barriers that may be implemented to reduce fish entrainment and impingement.

3.3. Preliminary conclusions on water use and abstraction

Following the assessment of water use and abstraction, our preliminary conclusions are that:

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

We consider the following 2 Assessment Findings to be appropriate:

Assessment Fining 32: A future operator shall engage with the local water supply company early in the site-specific stage. This is to ensure that sufficient quantities of fresh water can be supplied to meet the requirements of the UK HPR1000 or to determine whether an alternative source of fresh water will need to be identified.

Assessment Finding 33: A future operator shall ensure that the siting of the cooling water intake and outlets are BAT for the UK HPR1000 design at each specific site.

4. Discharges to surface water

Discharges to surface waters are controlled by The Environmental Permitting (England and Wales) Regulations 2016 (GB Parliament, 2016). An environmental permit is required for the discharge of any non-radioactive effluent to inland or coastal waters. Further information can be found at www.gov.uk/guidance/discharges-to-surface-water-and-groundwater-environmental-permits.

4.1. Assessment objectives

Our assessment for this topic area was aimed at:

- understanding the different effluent streams produced by the UK HPR1000 and the non-radioactive contaminants present
- understanding how each effluent stream produced by the UK HPR1000 is treated and disposed of

- understanding the potential environmental impact of the discharges based on the generic site
- deciding, based on the information provided for GDA, whether an environmental permit for a water discharge activity would need to be applied for at the site-specific stage

4.2. Assessment

4.2.1. Regulatory context

The RP demonstrated a good understanding of the main pieces of legislation relating to surface water discharges.

4.2.2. Assumptions

The RP made the following assumptions in relation to surface water discharges:

- Storage, monitoring and treatment of effluent streams implemented for the design will be in accordance with relevant guidance.
- The biocide dosing strategy will be determined at the site-specific stage.
- The reference plant for the information on the out-of-scope systems is Fangchenggang Nuclear Power Plant Unit 3 (FCG3).

We consider the assumptions to be reasonable at the GDA stage for a generic site. Any changes to these assumptions would require us to re-evaluate our assessment outcomes.

4.2.3. Effluent characterisation and treatment

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

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

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

Each of the 3 types of liquid effluents will be described, in turn, in relation to the effluent characterisation and treatment. During the course of our assessment to date, we have issued two Regulatory Queries related to discharges to surface water (RQ-UKHPR1000-0546 and RQ-UKHPR1000-0823). Each of these contained a number of individual queries which are discussed in the appropriate section below.

Effluents associated with radioactive waste streams

This sub-section focuses on the chemical characteristics and treatment techniques for the radioactive effluent streams.

In the UK HPR1000 design liquid radioactive effluents can be categorised as:

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

These effluent streams are managed and treated separately up to the point at which they enter the 'nuclear island liquid waste discharge system' (NLWDS) - see Figure 1 below. Treatment of these effluent streams takes place in the 'liquid waste treatment system' (LWTS). The process drain effluents are treated by demineralisation, chemical drain effluents are treated by evaporation, and the floor and laundry drains are treated by filtration. The treatment options for these effluents are intended to treat radioactive as well as chemical contaminants. We considered that there was not enough detail in the PCER on the treatment techniques proposed for the LWTS, so we raised a question in RQ-UKHPR1000-0546 to seek more information. GNSL's response provided some more information on the evaporation, filtration and demineralisation units, which we considered to be at an acceptable level of detail for GDA.

We also queried the use of detergents in RQ-UKHPR1000-0823. GNSL had indicated that the use of detergents in the plant laundry was for a future operator to decide, including if a laundry should be used at all. GNSL explained that the need for and use of a laundry depended on the radiological protection barrier and change room arrangements of a future operator depending on operational requirements. The NLWDS also accepts effluent from the coolant storage and treatment system (CSTS). Following treatment and monitoring, the effluents from the LWTS and the CSTS are discharged from NLWDS into the environment via the seal pit. Monitoring takes place from storage tanks in NLWDS to ensure the effluents are of a suitable quality to be released into the environment. If they are not, then they can be re-directed back into the LWTS for further treatment.

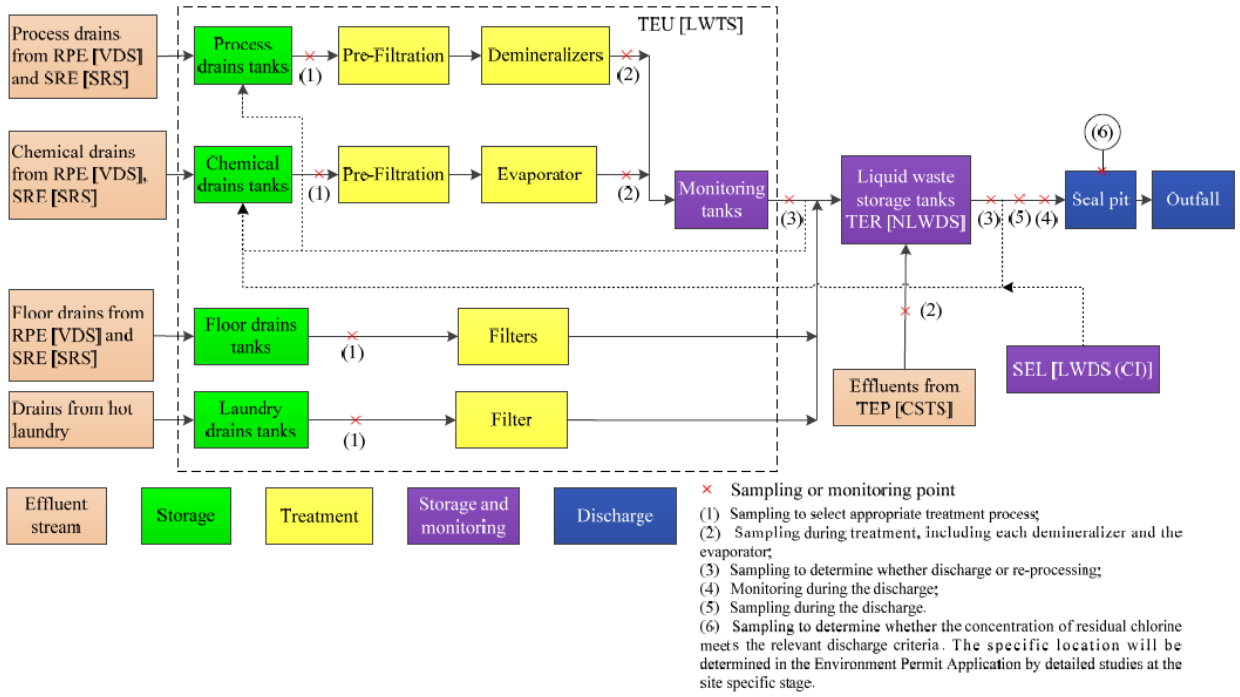

Figure 1: GNSL flow diagram for liquid radioactive effluent streams (GNSL, 2020b)

Figure 2 below shows the systems that are used to manage potentially radioactive effluents from the turbine hall (waste fluid collection system for conventional island - WFCSCI) and steam generator blowdown system (SGBS) before they go to the conventional island liquid waste discharge system (LWDS(CI)). The turbine hall effluents also have the potential to be oily so the waste fluid collection system for conventional island (WFCSI) is split into two parts - part 1 treats the potentially oily wastes while part 2 deals with the non-oily effluents. The potentially radioactive, oily effluents are treated by conventional oil/water separation techniques which removes the oil fraction from the effluent stream and is then dealt with separately by off-site recovery or disposal. The

remaining water fraction is sampled in storage tanks in the LWDS(CI) and then either released for discharge via the seal pit or directed to the appropriate treatment facility in the LWTS (see figure 1 and figure 2).

We noted that the flow diagrams provided (see Figure 1 above and Figure 2 below) included the option to either discharge the effluent directly into the environment (via the seal pit) or to divert it to be treated in the LWTS. We queried (RQ-UKHR1000-0546) what controls would be in place when deciding to divert an effluent stream that would normally go directly to the seal pit for discharge to the treatment plant at the LWTS instead. GNSL confirmed that the effluent is expected to be non-radioactive for the majority of the time but may, on occasion, become contaminated by small leakages of radioactivity from the primary to the secondary circuit. The primary circuit contains the coolant that removes heat from the reactor. Heat from the primary circuit is transferred (via a heat exchanger in the steam generators) to water in a secondary circuit, which produces steam that is used to drive the turbines that power the generator to generate electricity. Any radioactivity would be picked up in the monitoring carried out when the effluent is held in the storage tanks that are part of the LWDS(CI). Subsequently, the decision to discharge directly to the seal pit and into the environment (if no radioactive contamination or acceptable levels of chemical contamination is present) or to the LWTS for treatment is made by the operator, based on limits defined in its operating instructions. We are satisfied with the operational flexibility this diversion route offers in term of increased protection of the environment and will follow this through to our site-specific permitting stage to ensure the management systems and procedures provide for robust decision making at this crucial point in the system.

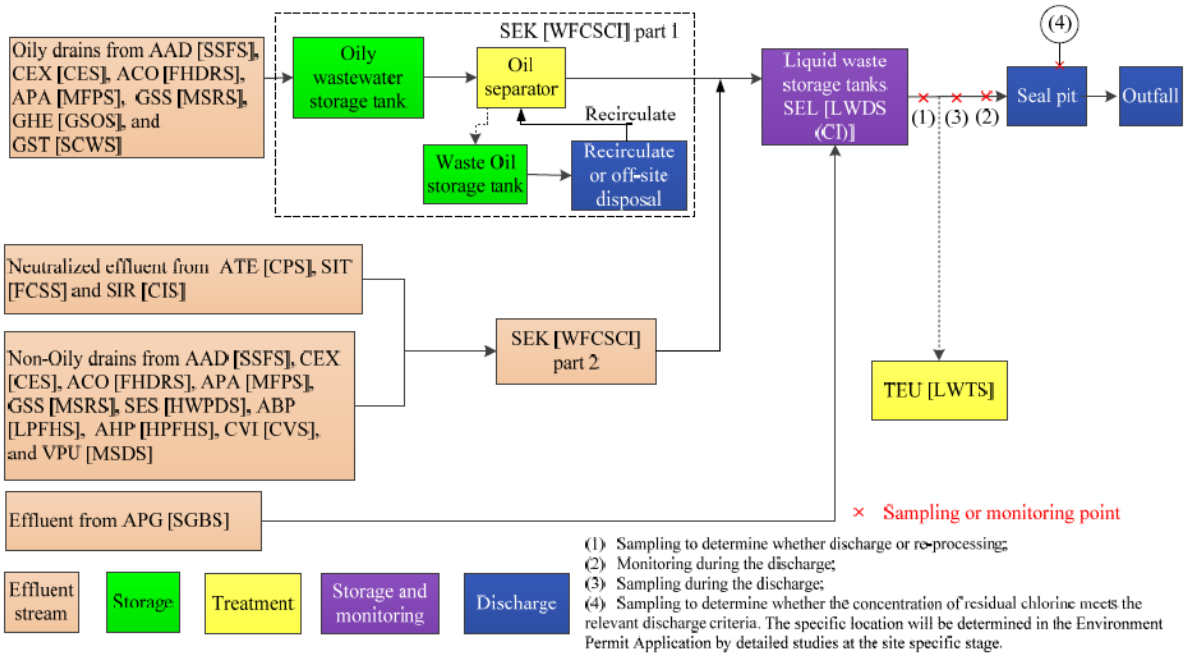

Figure 2: GNSL flow diagram for potentially radioactive effluent streams (GNSL, 2020b)

In the PCER, there are 7 flow diagrams used to describe the effluent management system. In an earlier version of the PCER, we noted some inconsistencies between the diagrams themselves and between the diagrams and the associated text, and we queried these in RQ-UKHPR1000-0546 and RQ-UKHPR1000-0823. GNSL accepted the comments and has made the necessary amendments in its latest version of the PCER (GNSL, 2020b).

Both the LWDS(CI) and the NLWDS are released to the seal pit before being discharged into the environment via the outfall. The seal pit is a structure designed to prevent air

getting back into the cooling water and effluent systems and is linked to the main site outfall into the environment.

GNSL has described the chemical characteristics of the radioactive waste streams in terms of the chemicals that are proposed for use in the primary and secondary circuits of the UK HPR1000. The main chemicals used are as follows:

- boric acid for reactivity control
- lithium hydroxide for pH control in the primary circuit
- hydrazine for corrosion control in the primary and secondary circuits
- ammonia for pH control in the secondary circuit
- trisodium phosphate as a corrosion inhibitor in the closed cooling systems
- detergents used in the hot laundry rooms

GNSL provided a supporting document 'Chemical Emission Inventory for Water Discharge' (GNSL, 2019b) to support the work carried out to establish the chemical load to be discharged via the NLWDS and the LWDS(CI) from the radioactive effluent streams. The chemical emission inventory document also includes chemicals used in the cooling water system. The chemical emission inventory was a substantial piece of work carried out by GNSL during the GDA process and we were updated regularly throughout the development of this report.

GNSL developed a method for establishing an inventory of chemical emissions. The first step was to establish a chemical inventory for the design. This was provided in the supporting document 'Chemical Inventory for UK HPR1000' (GNSL, 2019e). This document was a necessary starting point for this and for the COMAH assessment (see section 7 below). The whole site inventory was then used to select the chemicals that could end up in an effluent stream and therefore required assessing for this aspect of GDA. Once the specific chemicals had been selected, the route each chemical could take through the effluent streams was established, along with normal and maximum discharge scenarios. At this point, the estimated figures were considered in the context of OPEX from operating nuclear power plants. These figures were then used to calculate discharge estimates in terms of an average and maximum annual load (in kg). We would expect the calculations to include decontamination factors for each chemical, and GNSL's submission did include them. However, the sources of the values used for decontamination factors were not clear, so we queried some of these in RQ-UKHPR1000-0823. We specifically queried the decontamination factors used for boric acid (0.17) and lithium hydroxide (0.9). In its response, GNSL confirmed how OPEX had been used in calculating the boric acid decontamination factor. The calculations were also provided in the RQ response. The response regarding lithium hydroxide discussed the variability in factors that can affect treatment and, therefore, the decontamination factors. GNSL acknowledged that the variables make it very difficult to determine a reliable decontamination factor, so it based it on ion exchange fundamentals, literature data, laboratory experiments and OPEX.

The discharge estimates obtained for the UK HPR1000 were then compared with French and Chinese PWR fleets as well as the UK European pressurised reactor (UK EPR) design data. The results for all chemicals assessed, apart from hydrazine, show that discharges are comparable to the Chinese and French fleets and the UK EPR. GNSL explains that this could be due to the assumption at GDA that hydrazine will not be treated before discharge, whereas it is in the French fleet and the UK EPR. GNSL considers that the discharge estimates for hydrazine could be reduced by a future operator at the site-specific stage by applying treatment techniques. We asked GNSL for more information on this in RQ-UKHPR1000-0823, which remains open at the time of writing. In order to

ensure this is highlighted as an outcome from GDA, we have raised the following Assessment Finding, which also ensures refinement of the calculations for chemical emissions at the site-specific stage:

Assessment Finding 34: A future operator shall review the calculations for emissions of chemicals as part of the site-specific environmental risk assessment. Particular attention should be focussed on the application of possible treatment techniques for hydrazine to reduce the amount discharged to the environment, and therefore minimise any impact.

Subject to the Assessment Finding above, and RQ-UKHPR1000-0823, we are content with GNSL's conclusions for this aspect of the design.

Effluents associated with non-radioactive waste streams

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

- station sewer system part 1
- station sewer system part 2
- waste oil and non-radioactive water drainage system

These 3 systems have been classed as out of scope of GDA, but GNSL has provided some basic information on each.

The station sewer system part 1 accepts effluents from the non-radioactive parts of the nuclear island (for example, air conditioning systems and ventilation systems) as well as domestic sewage from a number of buildings. Being out of scope of GDA, no decisions have yet been made on the monitoring or treatment processes that would be appropriate as these will be site-specific design matters. However, GNSL has stated in its submission that a conventional activated sludge treatment process (like that used in many domestic sewage treatment works) could be appropriate. Following treatment, this effluent stream will be discharged directly to the environment via the main site outfall (not via the seal pit as the radioactive and cooling water effluent streams are).

The station sewer system part 2 collects site surface rainwater, roof water and uncontaminated water released from the circulating water system among other non-radioactive systems. For the purposes of GDA, this effluent stream is shown as being discharged directly into the environment via the main site outfall. However, the RP has stated in its submission that 'appropriate control arrangements will be incorporated into the UK HPR1000 design to comply with BAT' and that this is a site-specific matter.

The waste oil and non-radioactive water drainage system collects all the non-radioactive oily water from various sources. The proposed treatment is conventional oil separators. The oil fraction is taken out of the effluent stream and removed from site for treatment via conventional waste oil management routes. The water fraction is tested and, if it meets the necessary discharge criteria, discharged directly into the environment via the main site outfall.

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

Assessment Finding 35: A future operator shall ensure that the storage, treatment and monitoring systems for the 3 non-radioactive effluent streams provide the appropriate level of environmental protection for the receiving environment in terms

of quality of effluent discharged. This would be regulated by a water discharge activity permit.

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

Effluents associated with cooling water systems

The cooling water system comprises of 3 systems:

- circulating water system
- essential service water system
- auxiliary cooling water system

These systems are described in section 3.2.4 above in the context of water abstraction and use. When the water has been used to cool the various components of the design, because a once-through system is proposed, it will need to be discharged back into the environment under the terms of a water discharge activity permit. This assessment is based on the once-through cooling water system proposed by the RP for GDA. If an alternative cooling water technique is chosen at the site-specific stage, then this will need to be reassessed at that time.

In order to prevent biofouling of the internal systems, the abstracted cooling water is dosed with a biocide. GNSL has stated that the final dosing strategy is a site-specific matter for a future operator to decide. For the purposes of GDA, the RP has assumed sodium hypochlorite will be used as the biocide and has carried out the environmental impact assessment based on this (see section 4.2.4 below). The RP has, however, stated that whatever strategy is chosen, the residual chlorine (from the sodium hypochlorite) will be in the range of 0.1mg/l to 0.5mg/l, with a daily average of 0.2mg/l. These target values have been carried forward to the environmental risk assessment (section 4.2.4 below). A future operator will need to take into account the appropriate BREF (industrial cooling systems) and Environment Agency guidance when developing its site-specific strategy. For the purposes of GDA, the RP has proposed a final monitoring point for residual chlorine in the seal pit. This is acceptable for a final (compliance) monitoring point, but a future operator may wish to provide additional monitoring further upstream in the systems to ensure the EPR water discharge activity permit limits will be met.

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

Despite much of the above section leaving options open for a future operator to make at the site-specific design stage, we ask the RP to consider environmental impact of water discharges at GDA stage. The work the RP has carried out to prepare its 'Chemical Inventory for Water Discharge' has enabled suitably underpinned emission values to be developed to use in the environmental impact assessment.

4.2.4. Environmental impact assessment

The PCER (GNSL, 2020b) outlines GNSL's modelling work carried out for the environmental impact assessment and this is backed up by a more detailed supporting document 'Environmental Risk Assessment on Liquid Chemical Discharge' (GNSL, 2019c).

We ask the RP to provide an environmental impact assessment at GDA stage to determine whether the proposed emissions from the generic design could be considered

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

Assessment Finding 36: A future operator shall provide in an application for a water discharge activity environmental permit a site-specific environmental impact assessment for discharges to water. The modelling shall use site-specific parameters based on the environmental setting and the specific chemicals selected for use.

GNSL made a number assumptions in relation to the environmental risk assessment as follows:

- sodium hypochlorite is used as the biocide
- where an environmental quality standard (EQS) doesn't currently exist for a particular substance, then the predicted no-effect concentration (PNEC) was used in the assessment at GDA stage
- background water quality data was for an assumed location

Each of these assumptions will need to be refined when site-specific data are available.

The environmental impact assessment carried out for GDA was an initial screening assessment using our recommended H1 environmental risk assessment tool. The input parameters required for the impact assessment included information developed in the 'Chemical Emission Inventory for Water Discharge' document (GNSL, 2019b), background concentrations in the environment (assumed location) and average flow rates (estimated to be 55m^3/s).

GNSL followed through the series of tests as specified in our H1 guidance (our guidance can be found at https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit). We are satisfied that our approach was followed correctly for this impact assessment. The initial test compares the discharge concentration with the corresponding EQS. The discharge concentration is the concentration at the end of the pipe before the effluent enters the environment (in other words, with no further dilution). If the discharge concentration is lower than the corresponding EQS, then the substance is screened out from further assessment. The EQSs GNSL used in its assessment were for 'estuaries or coastal waters', so they are appropriate for the generic site proposed in this GDA.

The following substances were assessed:

- boron
- lithium hydroxide
- ammonia
- hydrazine
- chlorine (as TRO)
- copper (dissolved)
- iron
- nickel (dissolved)

- lead (dissolved)
- zinc (total)

All of the above substances were screened out after the initial test except chlorine and hydrazine, which were subjected to further tests.

The next test involved comparing the effective volume flux (EVF) with the allowable effective volume flux (AEVF) for buoyant discharges such as this, as described in our guidance (https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit). Chlorine was screened out from needing further assessment at this stage.

Hydrazine did not screen out and, as such, warrants particular attention at the site-specific stage. GNSL acknowledged this in its PCER (GNSL, 2020b) and supporting document 'Environmental Risk Assessment on Liquid Chemical Discharge' (GNSL, 2019c). If the H1 tool had produced this outcome when being used at a site-specific permitting stage, then we would require the operator to carry out more detailed modelling of the specific discharge in the specific environment. We do not consider it appropriate to ask for this at GDA stage, as there would be so many assumptions that the outcomes would have a high level of uncertainty associated with them.

The purpose of the H1 environmental risk assessment at GDA stage is to provide a screening assessment to demonstrate that the impact of discharges to surface waters from the UK HPR1000 could be at levels low enough to potentially allow a water discharge activity permit to be issued. This was found to be the case for all substances assessed except hydrazine. At the time of writing, we have 2 queries in RQ-UKHPR1000-0823 which have not yet been responded to. These 2 queries relate specifically to hydrazine and possible techniques to either reduce its usage or treat it in the effluent. We will assess GNSL's responses to these aspects of the RQ when we receive them.

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

Assessment Finding 36: A future operator shall provide in an application for a water discharge activity environmental permit a site-specific environmental impact assessment for discharges to water. The modelling shall use site-specific parameters based on the environmental setting and the specific chemicals selected for use.

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

4.2.5. Options for beneficial use of the waste heat

A nuclear power plant, like other thermal power generation processes, converts thermal energy into electrical power. It is not possible to convert 100% of the thermal energy into electricity, therefore residual heat in the cooling water is released into the environment. In our Process and Information Document (P&ID), we ask the RP to consider possible uses of the waste heat that would be compatible with the design.

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

- Agricultural sector - warm water could be used to heat commercial greenhouses.
- Industrial sector - warm water could be used to prevent ice forming in cold weather on roads or runways. Alternatively, it could be used as a source of heat for a desalination process.
- Civil sector - warm water may be used as part of a district heating scheme in residential dwellings, hospitals and public buildings.

Each of these uses requires the users to be in close proximity to the nuclear power plant. Although this is unlikely for some sectors, it is important that a future operator remains aware of any opportunities to reuse the residual heat from the process as an alternative to releasing it into the environment.

4.3. Preliminary conclusions on discharges to surface water

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

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

To ensure that the main elements are picked up at the site-specific stage, we have included the following 3 Assessment Findings:

Assessment Finding 34: A future operator shall review the calculations for emissions of chemicals as part of the site-specific environmental risk assessment. Particular attention should be focussed on the application of possible treatment techniques for hydrazine to reduce the amount discharged to the environment, and therefore minimise any impact.

Assessment Finding 35: A future operator shall ensure that the storage, treatment and monitoring systems for the 3 non-radioactive effluent streams provide the appropriate level of environmental protection for the receiving environment in terms of quality of effluent discharged. This would be regulated by a water discharge activity permit.

Assessment Finding 36: A future operator shall provide in an application for a water discharge activity environmental permit a site-specific environmental impact assessment for discharges to water. The modelling shall use site-specific parameters based on the environmental setting and the specific chemicals selected for use.

5. Discharges to groundwater

Discharges to groundwater are controlled by The Environmental Permitting (England and Wales) Regulations 2016 (GB Parliament, 2016). An environmental permit is required for any discharge either directly or indirectly into groundwater unless the activity is exempt. Further information can be found on the GOV.UK website at: www.gov.uk/guidance/discharges-to-surface-water-and-groundwater-environmental-permits.

5.1. Assessment objectives

Our assessment for this topic area was aimed at:

- identifying whether there were any planned discharges to groundwater
- deciding whether there are appropriate measures in the UK HPR1000 design to prevent any accidental discharges to groundwater

5.2. Assessment

5.2.1. Regulatory context

The RP demonstrated a good understanding of the main pieces of legislation relating to groundwater discharges.

5.2.2. Assumptions

The RP made the following assumptions in relation to groundwater discharges:

- All aqueous effluents are managed so that they discharge to a marine or estuary environment (see 'Discharges to surface water' above), therefore there is no need to discharge to groundwater.
- The plant has been designed to prevent accidental discharge to groundwater in accordance with relevant guidance.
- Design of containment measures for fire-fighting water is a site-specific matter.
- Management arrangements will be developed at the site-specific stage to prevent accidental releases to groundwater.

We consider the assumptions to be reasonable at the GDA stage for a generic site. The assumptions will need to be followed through to the site-specific stage to remain valid. Any changes to these assumptions are likely to affect our assessment outcomes.

5.2.3. Discharges

GNSL states that the UK HPR1000 does not include any requirement for routine discharges to groundwater and there will be no intentional discharges to groundwater.

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

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

GNSL states that the following measures will also be implemented:

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

The detailed site layout design can only be determined at the site-specific stage, therefore the exact arrangements for drainage, secondary containment (for example, bunding) and tertiary containment (for example, hardstanding linked to the drainage systems) are not known at GDA.

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

These types of environmental protection systems are regulated by us under a number of regimes (EPR16, COMAH15, pollution prevention advice), so we will be able to ensure they are implemented properly at the site-specific stage.

5.3. Preliminary conclusions on discharges to groundwater

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

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

6. Operation of installations (combustion plant and incinerators)

The Environmental Permitting (England and Wales) Regulations 2016 (GB Parliament, 2016) covers the operation of certain types of installations. Those installation activities that may be relevant to the operation of a UK HPR1000 are combustion and incinerating waste. Further information can be found on the GOV.UK website at: https://www.gov.uk/guidance/a1-installations-environmental-permits.

An environmental permit is required from us for a combustion activity if an operator is burning fuel in an appliance with a thermal rated input of 50MWth or burning fuel in 2 or more appliances on the same site with an aggregated thermal input of 50MWth or greater.

A permit is also required under the Greenhouse Gas Emissions Trading Scheme Regulations 2012 (GB Parliament, 2012) if the combustion activity has a net rated thermal input of 20MWth or greater.

An environmental permit is required for incinerating hazardous waste in a plant with a capacity of more than 10 tonnes a day or incinerating non-hazardous waste in a plant with a capacity of more than 3 tonnes an hour.

If relevant, the operator of a UK HPR1000 would be required to apply for an environmental permit from us before beginning operations.

6.1. Assessment objectives

Our assessment for this topic area was aimed at:

- understanding the combustion and incineration activities proposed for the design, and whether they are likely to require permits (under Environmental Permitting Regulations 2016 and/or Greenhouse Gas Emissions Trading Scheme Regulations 2012) at the site-specific stage
- where an environmental permit for combustion or incineration activities is likely to be required, assessing whether the proposals represent BAT
- where a greenhouse gas emissions permit is likely to be required, assessing how greenhouse gas monitoring will be carried out
- assessing how the Medium Combustion Plant Directive requirements are likely to apply to the design
- understanding the potential environmental impact of the discharges to air based on the generic site location

6.2. Assessment

6.2.1. Regulatory context

The RP demonstrated a good understanding of the main pieces of legislation relating to the permitting of installation activities and greenhouse gas emissions.

6.2.2. Assumptions

The RP made the following assumptions in relation to installation activities:

- The proposals made at GDA are based on the reference plant (FCG3), but it is acknowledged that these aspects of the design may change at the site-specific stage.
- There is no incineration activity included in the design of the UK HPR1000.
- Each emergency diesel generator (EDG) and station black out diesel generator (SBO DG) will be in its own building with an approximate height of 25m. The generator buildings will be on either side of the reactor building, but separate from it. The number of generators assessed for GDA are for one reactor unit.
- Pollution prevention abatement measures are assumed to be a site-specific matter, as is final stack height. Both of these aspects are highly dependent on the local site topography and meteorological conditions and will be optimised at the site-specific stage.
- Locally available diesel will be used that complies with the Sulphur Content of Liquid Fuels Regulations 2007 (GB Parliament, 2007).
- Each generator has a main fuel storage tank which is located in the basement of the diesel generator building.
- Emission limit values from the Medium Combustion Plant Directive (EU, 2015) will not apply to the UK HPR1000 design due to the low number of operating hours (<500 hours a year). See section 6.2.7 for more discussion on the Medium Combustion Plant Directive.

We consider the assumptions to be reasonable at the GDA stage for a generic site. Most of the assumptions will need to be reviewed and revised at the site-specific permitting stage. Any changes to these assumptions would require us to re-evaluate them.

6.2.3. Incineration activity installation

GNSL states that the UK HPR1000 design does not include any requirement for an on-site incinerator and it is assumed, for the purposes of GDA, that there will be no incineration of waste.

6.2.4. Combustion activity installation

GNSL states (GNSL, 2020b) that the combustion plant required in the UK HPR1000 design are as follows:

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

We expect this list to be refined as GDA progresses and this area will be re-visited in the final assessment report. We do not expect any potential changes to affect the environmental impact assessment carried out by GNSL and assessed here (section 6.2.6) but we will continue to assess any design changes that occur between consultation and the end of GDA to ensure the generic environmental impact assessments are amended accordingly, if necessary.

GNSL has considered the 2 smaller generators as out of scope of GDA and due to their relatively small size and we agree with this conclusion. The following assessment applies to the 3 EDGs and 2 SBO DGs.

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

The 3 EDGs are classed as nuclear safety equipment. They are included in the design to provide emergency power to the equipment related to the safe shutdown of the reactor in the event of a loss of off-site power supply. The EDGs are required to start up quickly and automatically in the event of a loss of off-site power.

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

GNSL describes the 3 operating conditions for the EDGs and SBO DGs as being:

- Commissioning to ensure reliable operation before they are formally brought into use. The commissioning testing periods are expected to be approximately 50 hours for each EDG and 40 hours for each SBO.
- Periodic testing is carried out to ensure the generators can be brought out of standby and into use as soon as they are required. Periodic tests are carried out once a month with an annual operation time of approximately 22 hours for each EDG and SBO DG.
- Loss of power
    - The EDGs will be operated if a loss of off-site power occurs and will continue operating until off-site power is restored. As this is a fault condition and necessary for nuclear safety, it is out of scope of our GDA process.

- The SBO DGs will be operated in the event of a station blackout and will continue until power is restored. As this is a fault condition and necessary for nuclear safety, it is out of scope of our GDA process.

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

At the time of writing, we are aware that work is ongoing to address some uncertainty over the power requirements of security arrangements, some safety related aspects may change the capacity of the generators, and the power requirements of the HVAC system. We will continue to assess any design changes that occur between consultation and the end of GDA to ensure the generic environmental impact assessments are amended accordingly, if necessary. The following details of our assessment are correct at the time of writing.

6.2.5. Comparison with sector guidance note

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

Assessment Finding 37: A future operator shall provide in an application for an environmental permit a BAT assessment of the specific combustion plant selected for use against the relevant BAT guidance at the time of application.

The BAT assessment GNSL provided for this GDA covers all the relevant topic areas we would expect to see for a proposed combustion plant, a summary of which is as follows.

Energy efficiency

GNSL states that it expects a future operator to develop an energy policy and energy management system at the site-specific stage as it greatly relies on the specific combustion plant procured at the time.

Avoidance, recovery and disposal of wastes

The main waste streams from the diesel generators are expected to be spent diesel and spent lube oil. The diesel will be considered spent, and therefore classed as a waste, if it is stored in the main storage tank (linked to each generator) for a long period of time without being used. This is likely to be the case because the generators are expected to be in standby mode for most of the time and only brought into use in the event of a loss of power supplies. GNSL proposes a control measure for this (periodic blow-down to remove any water). Both waste streams could potentially be treated by a specialist (and suitably permitted) contractor, but GNSL considers this to be a site-specific matter.

Operational issues

The sulphur content of the fuels will be subject to the relevant legislation and standards (GB Parliament, 2007).

Point source emissions to water

There are no liquid effluents generated as a result of operating the generators. Any waste generated in the event of an accident (for example, firewater) is expected to be accommodated in the oily wastewater route. This system comprises an oil interceptor and storage before release into the environment via the main site outfall. Any loss of containment in the diesel storage tanks (leaks, spills or catastrophic failure of storage tanks) can be controlled by the proposed mitigation measures (secondary and tertiary containment, leak detection, fire alarms and level alarm systems).

Point source emissions to air

GNSL considers the selection of diesel generators rather than gas turbines to be BAT due to the operational flexibility and rapid start-up characteristics. GNSL provides some manufacturer's data on release rates for the main pollutants (oxides of sulphur and nitrogen, carbon monoxide and particulate material).

During the course of our assessment we issued RQ-UKHPR1000-0822 which contained several queries, 2 of which relate to this section. We asked GNSL to review the contradiction between this section, which states that there would be no secondary abatement, and one of the assumptions (section 6.2.2 above) which stated that abatement would be a site-specific matter. In its response to the RQ, GNSL provided revised paragraphs that would be included in the next version of the PCER. This confirmed that abatement of the air emissions is not ruled out at GDA and can be considered, if necessary, at the site-specific stage. In RQ-UKHPR1000-0822, we also queried whether the manufacturer's data presented here relate to the environmental impact assessment. In its response, GNSL confirmed that the manufacturer's emission data were used to calculate the input parameters for the environmental impact assessment modelling. We are satisfied with this response and do not consider it necessary to look at this in any more detail at GDA stage. This is because the modelling will need to be carried out again at site-specific stage using real location information and emission data from the actual generators selected for use. We will carry out a more detailed assessment of the whole impact assessment as part of our determination for an environmental permit.

Fugitive emissions

GNSL considers the risk of fugitive emissions from the proposed combustion plant to be low. Should any leaks or spills occur, there would be appropriate secondary and tertiary containment measures in place to prevent release into the environment.

Monitoring

Monitoring is not proposed for releases to water as there are no planned emissions. GNSL acknowledges that monitoring emissions to air may be required, and states that a future operator will need to establish a full site-specific monitoring programme to include air emission monitoring from the diesel generators. While we agree with GNSL's conclusion on monitoring, it needs to go a little further to ensure compliance with the Medium Combustion Plant Directive (see section 6.2.7 below).

Other aspects that will need to form part of the site-specific BAT assessment include management systems, site condition report (for land quality purposes) and raw material usage.

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

6.2.6. Environmental impact assessment

The PCER outlines GNSL's environmental impact assessment and this is backed up by a more detailed supporting document 'Environmental Risk Assessment on Air Emission' (GNSL, 2019d).

We ask the RP to provide an environmental impact assessment at GDA stage to determine whether the proposed emissions from the generic design can be considered reasonable at the site-specific stage. The impact assessment is generic at this stage because the specific combustion plant and the environmental setting are not known. Both of these elements will need to be included in a more detailed site-specific modelling for the application for an installation activity environmental permit. To ensure this aspect is addressed, we raised the following Assessment Finding:

Assessment Finding 38: A future operator shall provide in an application for a combustion activity environmental permit a site-specific environmental impact assessment for discharges to air. The modelling shall use site-specific parameters based on the environmental setting and the specific combustion plant selected for use.

The environmental impact assessment carried out for GDA involved an initial screening assessment using our recommended H1 environmental risk assessment tool. The purpose of the initial screening assessment was to assess the ground level concentrations of the combustion plant emissions against the applicable relevant short-term and long-term air quality standards. The assessment was based on the operation of a single EDG or SBO DG operating separately. This is considered acceptable because the assessment only applies to commissioning and testing which are both planned activities. The assessment is based on the 3 EDGs operating for 66 hours a year and the 2 SBO DGs operating for 44 hours a year.

The initial screening assessment compared modelled emissions against human health benchmarks (for NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) and ecological benchmarks (for NO_2 and SO_2).

The outputs of the modelling for the EDGs showed NO_2 exceeding the relevant Environment Assessment Levels (EALs) in the long-term assessment, and NO_2, SO_2, CO and PM_{10} exceeding the relevant EALs in the short-term assessment. For the SBO DGs, only the relevant short-term EALs were exceeded for NO_2, SO_2, CO and PM_{10}. Particularly notable results were the modelled short-term NO_2 emissions for the ecological EALs, which were significantly higher than the benchmark for both the EDGs and the SBO DGs. Although these results could have initially been a cause for concern, it is important to note that the H1 tool used here is extremely conservative in order to apply a high level of protection to the environment.

At site-specific permitting stage, we would normally go on to require an applicant to carry out more detailed modelling using a more in depth air dispersion model (for example, AERMOD or ADMS). This is not reasonable to do at the GDA stage because the detailed models require a lot of information about the site and environmental setting that the emission point is situated in. The necessary level of detail is simply not available at GDA stage. As an alternative, we asked the RP to carry out a sensitivity analysis to better understand the sensitivity of the H1 tool to each of the model variables, and whether more acceptable ground level concentrations could be achievable at the site-specific stage.

The sensitivity analysis carried out by the RP was based on published Environment Agency guidance, which states that a sensitivity analysis should be based on:

- meteorology data
- emission parameters (for example, stack height)

- receptor grid resolution
- treatment of terrain and buildings

The detailed sensitivity analysis is presented in the supporting document 'Environmental Risk Assessment on Air Emission' (GNSL, 2019d) and summarised in the PCER (GNSL, 2020b). The RP chose to focus on the highest results from the H1 assessment, which were outlined above as particularly notable: the short-term ecological assessment for NO_2. The outcome of the sensitivity analysis found that the parameters that are most sensitive (that is, those that affect the results the most) are stack height, meteorology and buildings. The results show that a stack height of 28m would bring the ground level concentrations of NO_2 at the site boundary below the relevant EALs for both the EDGs and the SBO DGs. For the EDGs, the modelled stack height had to be increased to 40m in order to bring the on-site ground level emissions below the relevant EAL. These stack heights are not unrealistic on a nuclear site. These conclusions are underpinned by the detailed analysis assessment presented by the RP in its submission (GNSL, 2019d).

The decision on final stack heights for the combustion plant is a site-specific matter for a future operator. It is also acknowledged that the final plant layout and further detailed dispersion modelling may reduce the final stack height needed. The purpose of the screening assessment and sensitivity analysis was to demonstrate that the impact of emissions from the combustion plant on the UK HPR1000 could be realistically reduced to acceptable levels to potentially allow a permit to be issued.

The operator will have to carry out site-specific air dispersion modelling as part of the permit application to demonstrate compliance with air quality standards and to demonstrate that the environmental impact from the combustion plant installation is acceptable. We consider the following Assessment Finding (that was introduced above) appropriate to ensure this happens:

Assessment Finding 38: A future operator shall provide in an application for a combustion activity environmental permit a site-specific environmental impact assessment for discharges to air. The modelling shall use site-specific parameters based on the environmental setting and the specific combustion plant selected for use.

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

6.2.7. Medium Combustion Plant Directive

Consideration of the Medium Combustion Plant Directive (MCPD) (EU, 2015) is not currently included in our P&ID because it is a relatively new piece of legislation. We raised this with the RP and asked it to consider how MCPD would apply to its proposed generators. The legislation is fairly new and quite complex, so we raised RQ-UKHPR1000-0680 to try and help the RP understand our expectations for GDA. The Medium Combustion Plant Directive is implemented in the UK by a 2018 amendment to the Environmental Permitting Regulations (GB Parliament, 2018) and the inclusion of Schedule 25A and 25B. RQ-UKHPR1000-0680 directed the RP to the relevant legislation and guidance.

GNSL had initially stated that because its proposed hours of operation fell below the threshold of 500 hours a year that the MCPD did not apply. This is not correct and the RQ was intended to help the RP assess the requirements of the regulations properly. The MCPD applies to all combustion plant between 1 and 50MW, so all the generators will be

classed as medium combustion plant. They will need to be permitted as such, and this is likely to be as part of the installation environmental permit. The legislation does provide a threshold of 500 hours a year under which the emission limits do not apply, but a permit will be required and the permit will still include monitoring requirements for certain parameters (for example, carbon monoxide and oxides of nitrogen). This will mean that suitable monitoring infrastructure will need to be designed into each generator to enable safe and accurate monitoring to be carried out. Separate regulatory requirements relating to 'specified generators' do not apply to these combustion plant because they are exempt due to the fact that they provide a nuclear safety role on a nuclear licensed site. We are now content that the RP has addressed MCPD correctly in the current version of the PCER (GNSL, 2020b).

6.2.8. Greenhouse gas emission monitoring

The UK HPR1000 combustion plant will require a permit from us under the Greenhouse Gas Emission Trading Scheme Regulations 2012 (GB Parliament, 2012) as the total aggregated thermal input exceeds the 20MW threshold set out in those regulations.

GNSL states that the proposed approach to monitoring greenhouse gas emissions will meet the requirements contained in ‘General guidance for installations (Monitoring and Reporting Regulation Guidance Document number 1)’ (EU, 2012b), which provides guidance on how to meet the requirements of the Monitoring and Reporting Regulation for Greenhouse Gas Emissions (EU, 2012a). GNSL states that it will follow the standard method used for calculating emissions as outlined in the relevant guidance document (EU, 2012b). The standard method involves measuring fuel and process inputs and applying appropriate emission, process and oxidation factors to calculate the total emissions.

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

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

6.3. Preliminary conclusions on operation of installations

Following our assessment of the operation of installations, our preliminary conclusions are that:

- the UK HPR1000 combustion plant (diesel generators) is likely to be a Part A(1) installation as described in Section 1.1 of Chapter 1 in Part 2 of Schedule 1 of The Environmental Permitting (England and Wales) Regulations 2016 and will, therefore, require an environmental permit from the Environment Agency
- several aspects of the GDA submission will need to be revised and updated when site-specific data are available. The main aspects that will need considering further are:
    - a BAT assessment for the chosen diesel generators
    - the application of medium combustion plant legislative requirements. This may require the necessary monitoring infrastructure to be included in the design (in line with technical guidance note M1 (Environment Agency, 2017))
    - site-specific modelling to demonstrate compliance with air quality objectives
    - the UK HPR1000 combustion plant will also require a permit under the Greenhouse Gas Emissions Trading Scheme Regulations 2012 (GB Parliament, 2012)

To ensure that the main elements are picked up at the site-specific stage, we have included the following 2 Assessment Findings:

Assessment Finding 37: A future operator shall provide in an application for an environmental permit a BAT assessment of the specific combustion plant selected for use against the relevant BAT guidance at the time of application.

Assessment Finding 38: A future operator shall provide in an application for a combustion activity environmental permit a site-specific environmental impact assessment for discharges to air. The modelling shall use site-specific parameters based on the environmental setting and the specific combustion plant selected for use.

7. Substances subject to the Control of Major Accident Hazards (COMAH) Regulations

The Control of Major Accident Hazards (COMAH) Regulations (GB Parliament, 2015a) apply to establishments that store or use quantities of named or generic categories of dangerous substances above specified qualifying thresholds. COMAH dangerous substances are defined by the Regulations (GB Parliament, 2015a) and include chemicals, oils or explosives. The aim of the regulations is to prevent or mitigate the consequences of major accidents. A major accident could involve an uncontrolled release, fire or explosion that has serious consequences for human health or the environment. A major accident to the environment (MATTE) would cause severe and/or long-term damage to the built or natural environment. In England, we share the responsibility for enforcing COMAH on nuclear licensed sites with the Office for Nuclear Regulation (ONR) working as a joint competent authority. Further information can be found at www.hse.gov.uk/COMAH.

7.1. Assessment objectives

Our assessment for this topic area was aimed at:

- deciding whether the UK HPR1000 would be a COMAH establishment based on the proposed chemical inventory
- deciding whether the UK HPR1000 design included measures to prevent a MATTE if the COMAH Regulations were applicable

7.2. Assessment

7.2.1. Regulatory context

The RP demonstrated a good understanding of the COMAH Regulations. GNSL particularly noted that COMAH does not apply to radioactive substances, which is correct.

7.2.2. Assumptions

The RP made the following assumptions in relation to substances subject to the COMAH Regulations:

- The wider GDA scope considers a single unit, but in order for the COMAH assessment to be more meaningful, GNSL agreed at an early stage in the GDA process to consider 2 units for the COMAH assessment, as it is more usual to deploy nuclear reactors in pairs. Under COMAH, threshold quantities of dangerous substances need to be exceeded in order for the regulations to apply. Considering 2 units at GDA stage

ensures that any design modifications required to comply with COMAH are not missed by assessing one unit in isolation.

- Details of chemicals to be used in construction and decommissioning are out of scope of GDA as the detail is not available at GDA stage. The COMAH assessment, therefore, only applies to commissioning and operational phases of the plant's life cycle.
- Assessment of chemicals used for decommissioning will be carried out towards the end of the operational phase of the plant and will depend on the future operator's choice and decommissioning techniques available at that time.
- Some substances, such as paints, will be chosen by a future operator so the hazard information is not available for GDA stage. These types of substances have been excluded from this assessment and they are unlikely to impact on the conclusions reached during GDA. GNSL has, however, included all the substances that are expected to be held in larger quantities.

We consider the assumptions to be reasonable at the GDA stage for a generic site and that a meaningful assessment can be carried out. Some of the assumptions will need to be followed through to the site-specific stage. Any changes to these assumptions are likely to affect our assessment outcomes.

7.2.3. GNSL's approach to carrying out the COMAH assessment

GNSL outlined its approach to carrying out the COMAH assessment to establish whether the regulations apply to the design. The main points of the approach were:

- step 1 - develop an inventory of chemicals (see 7.2.4 below)
- step 2 - classify the dangerous substances according to the Classification, Labelling and Packaging Regulation (EU, 2008a) and identify the corresponding qualifying thresholds in the COMAH Regulations
- step 3 - carry out the comparison against upper and lower tier thresholds provided in the COMAH Regulations. The COMAH Regulations are set out in such a way that a site (or 'establishment' as defined by the regulations) can be classed as either upper tier or lower tier depending on the quantities of dangerous substances present
- step 4 - application of the 'aggregation rule' and '2% rule'. Both of these rules are provided by the COMAH Regulations.
    a. The aggregation rule must be applied when no individual dangerous substance is present in a quantity above or equal to a qualifying threshold. The aggregation rule ensures that substances with similar hazards associated with them (health, physical or environmental hazards) are added together. This determines whether the establishment as a whole contains sufficient quantities of dangerous substances for the COMAH Regulations to apply.
    b. The 2% rule states that any dangerous substance present in quantities less than 2% of the appropriate threshold (identified in step 2 above) can be excluded from the COMAH assessment as long as its location prevents it from initiating a major accident.

We assessed the approach GNSL originally outlined (in GNSL, 2020a) and found an issue with how the aggregation and 2% rule had been applied. We issued RQ-UKHPR1000-0821 to ask GNSL how it could apply the location aspect of the 2% rule at GDA stage. In its response, GNSL acknowledged this and has revised its assessment to consider the whole inventory at GDA stage and not remove any substances in quantities less than 2%

of the relevant threshold. We accept the response and this revised approach because it ensures that none of the inventory is missed from the site-specific assessment. GNSL provided a revised set of assessment tables that will be included in the latest version of the PCER (GNSL, 2020b) and 'COMAH Assessment for UK HPR1000' (GNSL, 2019f). The revised assessment did not change the outcome of the COMAH assessment.

7.2.4. Chemical inventory

The first step in a COMAH assessment is to establish what dangerous substances will be present at the site. GNSL outlined the work it carried out to establish a chemical inventory in the PCER (GNSL, 2020b) and this is underpinned by a more detailed supporting document (GNSL, 2019e). The chemical inventory has been based on operational experience from the wider CGN fleet of nuclear power plant. GNSL has presented an inventory of chemicals with corresponding concentrations, how each will be used and the maximum storage quantities. Two separate inventories have been presented at GDA, one for commissioning and one for the operational phase of the plant's life cycle.

7.2.5. GNSL findings from the COMAH assessment

GNSL has provided an outline of its COMAH assessment in the PCER (GNSL, 2020b) and this is underpinned by a more detailed supporting document (GNSL, 2019f). This part of the assessment covers steps 2, 3 & 4 outlined in section 7.2.3 above.

In its submission GNSL has presented tables showing the outcome of its COMAH assessment procedure (GNSL, 2020b and outlined in section 7.2.3 above). The assessment has been separated into a number of operating scenarios as follows:

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

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

The first set of tables (in GNSL, 2020b) compare the chemical inventory against the COMAH thresholds. The 2% rule was originally applied at this stage (in GNSL, 2020a), but this has subsequently been removed following RQ-UKHPR1000-0821.

The second set of tables (in GNSL 2020b) apply the aggregation rule.

In RQ-UKHPR1000-0821 we queried some of the table numbering and discrepancies in the quantity of hydrazine between the PCER (GNSL, 2020a) and the 'COMAH Assessment' supporting document (GNSL, 2019f). GNSL accepted the comments and has stated that it will include the necessary revisions in the latest version of the documents. The amendments will not affect the conclusions of the COMAH assessment.

Having followed through the procedure outlined in section 7.2.3 above, GNSL concludes that the UK HPR1000 will not be subject to COMAH Regulations during the commissioning and operational phases of the plant’s life cycle. Construction and decommissioning phases have been agreed as being out of scope of GDA (see 7.2.2 'Assumptions' above).

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

Assessment Finding 39: Based on the information presented at GDA, the UK HPR1000 will not be a COMAH establishment during commissioning or operational

phases. A future operator shall keep the proposed chemical inventories under review so any applicability of COMAH can be identified early and the necessary major accident prevention measures can be installed.

7.2.6. Potential measures to prevent a major accident to the environment (MATTE)

Despite the outcome of the assessment being that the UK HPR1000 will not be subject to the COMAH Regulations, GNSL has fulfilled the P&ID requirement to describe the measures it could use to prevent a MATTE should the inventory (and therefore COMAH assessment) change at the site-specific stage. We welcome this approach as it ensures that any future detailed design and layout of the site considers COMAH.

In the PCER (section 8.7.7) on potential measures to prevent a MATTE there is a focus on hydrazine, whereas the corresponding section in the 'COMAH Assessment' supporting document is more general, and therefore more appropriate for GDA. We queried this discrepancy in RQ-UKHPR1000-0821. GNSL confirmed in its response that this was as a result of hydrazine being identified in an earlier version of the assessment as being subject to COMAH regulation. Subsequent optimisation of proposed hydrazine storage and use and more detailed assessment resulted in hydrazine not being subject to COMAH. The focus on hydrazine in this section is no longer needed and has been rewritten to be more in line with the, more acceptable, corresponding section in the 'COMAH Assessment' (GNSL, 2019f).

In the summary, GNSL has identified the main aspects of primary, secondary and tertiary containment measures in the 'COMAH Assessment' supporting document (GNSL, 2019f). If COMAH is found to apply to the operations at the site at a later date, then these measures will need to be expanded to cover wider aspects such as offloading procedures, COMAH critical equipment, maintenance, management systems and human factors. However, the level of detail GNSL presented in its submission is considered sufficient to demonstrate an awareness at the GDA stage.

7.3. Preliminary conclusions on substances subject to the Control of Major Accident Hazards Regulations

Following the assessment of substances relevant to COMAH and based on the information submitted, our preliminary conclusions are that:

- the UK HPR1000 will not be subject to the COMAH Regulations
- changes in inventory at the site-specific stage need to be kept under review to ensure a relevant threshold for the COMAH regulations isn’t exceeded. If any of the generic design assumptions change at a site-specific stage, then this preliminary conclusion will need to be reconsidered

We have also concluded that one Assessment Finding would be appropriate:

Assessment Finding 39: Based on the information presented at GDA, the UK HPR1000 will not be a COMAH establishment during commissioning or operational phases. A future operator shall keep the proposed chemical inventories under review so any applicability of COMAH can be identified early and the necessary major accident prevention measures can be installed.

It should be noted that the above preliminary conclusion relates only to major accidents to the environment. Our partner in the competent authority for COMAH15 regulation, ONR, is responsible for assessing matters relating to impacts on people.

8. Fluorinated greenhouse gases and ozone-depleting substances

Fluorinated gases (F-gases) are very powerful greenhouse gases that contribute to climate change if released into the atmosphere.

Many sites have air conditioning and refrigeration units which use fluorinated gases. These gases are often known collectively as ‘hydrofluorocarbons’ (HFCs) or ‘F-gases’. The gases, if released into the atmosphere, contribute to climate change as they are greenhouse gases with many times the potency of carbon dioxide. The Fluorinated Greenhouse Gases Regulations 2015 (GB Parliament, 2015b) place certain obligations on people who produce, supply and use F-gases. The Environment Agency is the enforcing authority for these regulations in England.

Ozone-depleting substances (ODS) are gases that damage the ozone layer in the upper atmosphere. ODS have been largely phased out in Europe, but may still exist in older equipment. There are also a few exceptions for certain uses. Common uses for ODS include refrigeration and air-conditioning equipment.

8.1. Assessment objectives

Our assessment for this topic area was aimed at:

- understanding whether any equipment included in the design will contain fluorinated greenhouse gases (F-gas) and/or ozone-depleting substances (ODS)
- where these gases are included in the design, understand the measures proposed to prevent and minimise leakage of such substances

8.2. Assessment

8.2.1. Regulatory context

The RP demonstrated a good understanding of the main pieces of legislation relating to F-gas and ODS.

8.2.2. Assumptions

The RP made the following assumptions in relation to F-gas and ODS:

- No ODS will be used in the UK HPR1000.
- F-gases selected for GDA of the UK HPR1000 are based on those used in the reference plant HPR1000 (Fangchenggang Nuclear Power Station Unit 3).
- The gases chosen will not be phased out (due to legislative changes) before the plant is brought into operation.

We consider the assumptions to be reasonable at the GDA stage for a generic site. The assumptions will need to be replaced by real information at the site-specific stage. Any changes to these assumptions would require us to re-evaluate them.

8.2.3. Equipment using F-gas

A number of F-gases are currently proposed to be used in the UK HPR1000 design in the refrigeration system, fire protection system and as insulating gases. These types of uses are common in other industrial sectors in the UK. GNSL specifies the list of F-gases proposed and these are as follows:

- HFC-134a - refrigerant in chiller units

- R407C - refrigerants in air conditioning systems
- HFC-236fa - mobile and portable fire extinguishing equipment
- HFC-227ea - gas fire extinguishing system
- Sulphur hexafluoride - insulate switchgear in the generator circuit breaker

None of the above substances at the proposed quantities are either banned now or are currently planned to be banned in the near future. Their use is, however, in a legislatively controlled phase down and alternatives will need to be sourced. The legislation controlling these gases may, however, change over time. GNSL should keep the proposed F-gases under review to ensure their continued use at the required quantities remains legally possible in the UK.

In the PCER submission, GNSL acknowledges this and presents some possible alternatives for future use, namely R513a and R-1233zd as possible alternatives for HFC-134a. GNSL concludes that the final choice of F-gases to be used in the UK HPR1000 is a site-specific matter for a future operator. We consider GNSL's proposals and conclusion to be acceptable at GDA stage. In order to ensure the extent of the GDA assessment is carried through into the site-specific stage, we consider the following Assessment Finding to be appropriate:

Assessment Finding 40: A future operator shall keep the fluorinated greenhouse gases proposed for use in the UK HPR1000 under review to ensure they continue to be legally acceptable for use.

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

8.3. Preliminary conclusions on fluorinated greenhouse gases and ozone-depleting substances

Following our assessment of the use of fluorinated greenhouse gases and ozone-depleting substance and based on the information submitted, our preliminary conclusions are that:

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

We have also concluded that one Assessment Finding would be appropriate:

Assessment Finding 40: A future operator shall keep the fluorinated greenhouse gases proposed for use in the UK HPR1000 under review to ensure they continue to be legally acceptable for use.

9. Compliance with Environment Agency requirements for GDA

Compliance with Environment Agency requirements for GDA are summarised in Table 3 below. All are subject to associated Assessment Findings and further assessment at site-specific permitting stage.

Table 3: Compliance with Environment Agency requirements for GDA

Requirements from P&ID	Comments
P&ID Item 8 - Water use and abstraction	If fresh water is provided by the local water company, then an abstraction licence is not required. An abstraction licence would not be required if cooling water is abstracted from open coastal waters, but it is likely to be required if an estuary location is chosen.
P&ID Item 8 - Discharges to surface waters	A water discharge activity environmental permit is likely to be required for the design. Outstanding questions on hydrazine in RQ-UKHPR1000-0823.
P&ID Item 8 - Discharges to groundwater	There are no proposed discharges to groundwater.
P&ID Item 8 - Operation of installations (combustion plant and incinerators)	An installation activity permit and Greenhouse Gas Emissions Trading Permit are likely to be required for the design.
P&ID Item 8 - Substances subject to the Control of Major Accident Hazards Regulations	The GDA assessment shows that the UK HPR1000 will not be subject to the COMAH Regulations during its commissioning and operational phases.
P&ID Item 8 - Fluorinated greenhouse gases and ozone-depleting substances	No ODS are proposed to be used in the UK HPR1000. Proposed quantities of specific fluorinated greenhouse gases to be used in the design are currently acceptable under the relevant legislation and in common with current UK practice.

10. Public comments

GNSL received 3 public comments up to 30 June 2020 concerned directly with the 'other environmental regulations' assessment area.

Two of the comments relate to cooling water abstraction and discharge and the potential impact on the Blackwater Estuary adjacent to the Bradwell site.

The third comment related to the impact of heat on the Blackwater Estuary from the cooling water discharge. Impact of heat is a site-specific matter that has been deemed out of scope of GDA.

We've seen the comments and GNSL's responses. These matters will not be addressed during GDA, but would be addressed in detail at the site-specific permitting stage should proposals to construct a station come forward.

11. Conclusion

We have come to the following preliminary conclusions from our assessment of the 'other environmental regulations' topic area for the UK HPR1000:

Water use and abstraction

Following the assessment of water use and abstraction, our preliminary conclusions are that:

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

We consider the following 2 Assessment Findings to be appropriate:

Assessment Fining 32: A future operator shall engage with the local water supply company early in the site-specific stage. This is to ensure that sufficient quantities of fresh water can be supplied to meet the requirements of the UK HPR1000 or to determine whether an alternative source of fresh water will need to be identified.

Assessment Finding 33: A future operator shall ensure that the siting of the cooling water intake and outlets are BAT for the UK HPR1000 design at each specific site.

Discharges to surface water

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

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

To ensure that the main elements are picked up at the site-specific stage, we have included the following 3 Assessment Findings:

Assessment Finding 34: A future operator shall review the calculations for emissions of chemicals as part of the site-specific environmental risk assessment. Particular attention should be focussed on the application of possible treatment techniques for hydrazine to reduce the amount discharged to the environment, and therefore minimise any impact.

Assessment Finding 35: A future operator shall ensure that the storage, treatment and monitoring systems for the 3 non-radioactive effluent streams provide the appropriate level of environmental protection for the receiving environment in terms of quality of effluent discharged. This would be regulated by a water discharge activity permit.

Assessment Finding 36: A future operator shall provide in an application for a water discharge activity environmental permit a site-specific environmental impact assessment for discharges to water. The modelling shall use site-specific parameters based on the environmental setting and the specific chemicals selected for use.

Discharges to groundwater

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

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

Operation of installations (combustion plant and incinerators)

Following our assessment of the operation of installations, our preliminary conclusions are that:

- the UK HPR1000 combustion plant (diesel generators) is likely to be a Part A(1) installation as described in Section 1.1 of Chapter 1 in Part 2 of Schedule 1 of The Environmental Permitting (England and Wales) Regulations 2016 and will, therefore, require an environmental permit from the Environment Agency
- several aspects of the GDA submission will need to be revised and updated when site-specific data are available. The main aspects that will need further consideration are:
    - a BAT assessment for the chosen diesel generators
    - the application of medium combustion plant legislative requirements. This may require the necessary monitoring infrastructure to be included in the design (in line with technical guidance note M1 (Environment Agency, 2017))
    - site-specific modelling to demonstrate compliance with air quality objectives

- the UK HPR1000 combustion plant will also require a permit under the Greenhouse Gas Emissions Trading Scheme Regulations 2012 (GB Parliament, 2012)

To ensure that the main elements are picked up at the site-specific stage, we have included the following 2 Assessment Findings:

Assessment Finding 37: A future operator shall provide in an application for an environmental permit a BAT assessment of the specific combustion plant selected for use against the relevant BAT guidance at the time of application.

Assessment Finding 38: A future operator shall provide in an application for a combustion activity environmental permit a site-specific environmental impact assessment for discharges to air. The modelling shall use site-specific parameters based on the environmental setting and the specific combustion plant selected for use.

Control of Major Accident Hazards Regulations

Following the assessment of substances relevant to COMAH, based on the information submitted, our preliminary conclusions are that:

- the UK HPR1000 will not be subject to the COMAH Regulations
- changes in inventory at the site-specific stage need to be kept under review to ensure a relevant threshold for the COMAH regulations isn't exceeded. If any of the generic design assumptions change at a site-specific stage, then this preliminary conclusion will need to be reconsidered

We have also concluded that one Assessment Finding would be appropriate:

Assessment Finding 39: Based on the information presented at GDA, the UK HPR1000 will not be a COMAH establishment during commissioning or operational phases. A future operator shall keep the proposed chemical inventories under review so any applicability of COMAH can be identified early and the necessary major accident prevention measures can be installed.

Fluorinated greenhouse gases and ozone-depleting substances

Following our assessment of the use of fluorinated greenhouse gases and ozone-depleting substances, based on the information submitted, our preliminary conclusions are that:

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

We have also concluded that one Assessment Finding would be appropriate:

Assessment Finding 40: A future operator shall keep the fluorinated greenhouse gases proposed for use in the UK HPR1000 under review to ensure they continue to be legally acceptable for use.

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GNSL. 2019e	‘Chemical Inventory for UK HPR1000’ GHX00100012DOHB03GN Rev E December 2019
GNSL. 2019f	‘COMAH Assessment for UK HPR1000’ GHX00100013DOHB03GN Rev E December 2019
GNSL. 2019g	‘Scope for UK HPR1000 GDA Project’ HPR-GDA-REPO-0007 Rev 001 July 2019
GNSL. 2020a	‘Pre-Construction Environmental Report Chapter 8 - Conventional Impact Assessment’ HPR/GDA/PCER/0008 Rev.001 January 2020 (V1)
GNSL. 2020b	‘Pre-Construction Environmental Report Chapter 8 - Conventional Impact Assessment’ HPR/GDA/PCER/0008 Rev.001-1October 2020 (V1.1)
GNSL. 2020c	‘Pre-Construction Environmental Report Chapter 2 - Generic Site Description’ HPR/GDA/PCER/0002 Rev.001-1 October 2020 (V1.1)

Abbreviations

Abbreviation	*Meaning*
AEVF	Allowable effective volume flux
BAT	Best available techniques
BREF	Best available techniques reference
COMAH	Control of Major Accident Hazards
EAL	Environmental assessment levels
EDG	Emergency diesel generator
EPR	Environmental Permitting Regulations
EQS	Environmental quality standard
EU	European Union
EVF	Effective volume flux
FCG3	Fangchenggang Unit 3 (reference plant)
GB	Great Britain
GDA	Generic design assessment
GNSL	General Nuclear System Limited
HFC	Hydrofluorocarbons
HVAC	Heating, ventilation and air conditioning
MATTE	Major accident to the environment
MCPD	Medium Combustion Plant Directive
ODS	Ozone-depleting substances
ONR	Office for Nuclear Regulation
P&ID	Process and Information Document

Abbreviation	*Meaning*
PCER	Pre-Construction Environmental report
PM	Particulate matter
PNEC	Predicted no-effect concentration
SBO DG	Station blackout diesel generator
RI	Regulatory Issue
RO	Regulatory Observation
RP	Requesting Party
RQ	Regulatory Query
TRO	Total residual oxygen
UK	United Kingdom

Appendix 1: GNSL documentation

Table 1 - GNSL documentation reviewed for this assessment

Title	Document number
Pre-Construction Environmental Report Chapter 8 - Conventional Impact Assessment - V0	HPR/GDA/PCER/0008 Rev. 000-1 November 2018
Pre-Construction Environmental Report Chapter 8 - Conventional Impact Assessment - V1	HPR/GDA/PCER/0008 Rev.001 January 2020
Pre-Construction Environmental Report Chapter 2 - Generic Site Description - V1.1	HPR/GDA/PCER0002 Rev.001-1 October 2020
Pre-Construction Environmental Report Chapter 8 - Conventional Impact Assessment - V1.1	HPR/GDA/PCER0008 Rev.001-1 October 2020
Fresh Water Requirements Calculation	GH000500001DCSG02GN Rev C June 2019
Chemical Inventory for Water Discharge	GHX00530002DOHB02GN Rev C November 2019
Environmental Risk Assessment on Liquid Chemical Discharge	GHX00530005DOHB02GN Rev C October 2019
Environmental Risk Assessment on Air Emission	GHX00530006DOHB02GN Rev A July 2019
Chemical Inventory for UK HPR1000	GHX00100012DOHB03GN Rev E December 2019
COMAH Assessment for UK HPR1000	GHX00100013DOHB03GN Rev E December 2019
Scope for UK HPR1000 GDA Project	HPR-GDA-REPO-0007 Rev 001 July 2019

Appendix 2: Summary of Regulatory Queries relating to other environmental regulations

The following table summarises the RQs that are most relevant to other environmental regulations for the UK HPR1000 (There are no Regulatory Observations or Regulatory Issues relevant to this topic area).

RQ/RO/RI	Date issued	Title and summary
Regulatory Queries		
RQ-UKHPR1000-0546	18-Nov-2019	Discharges to surface waters • GNSL was asked to clarify a number of points regarding the liquid waste management systems.
RQ-UKHPR1000-0680	13-Mar-2020	Medium combustion plant • GNSL was provided with the relevant guidance on medium combustion plant.
RQ-UKHPR1000-0821	26-May-2020	COMAH general queries • GNSL was requested to provide further information on various aspects of its COMAH assessment.
RQ-UKHPR1000-0822	26-May-2020	Combustion installation and air emission risk assessment • GNSL was requested to provide further information on various aspects of its submission related to the operation of installations.
RQ-UKHPR1000-0823	30-Jun-2020	Discharges to surface waters and supporting documents • GNSL was asked to clarify various points regarding its discharges to surface water submissions. NOTE - this RQ remains open at the time of writing.
RQ-UKHPR1000-0824	26-May-2020	Water use calculations • GNSL was asked to clarify some of the water use calculations it had provided.
Regulatory Observations		
None		

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