Preliminary detailed assessment of gaseous and liquid discharges of radioactive waste for General Nuclear System Limited's UK HPR1000 design - AR04

Version 1, 11 January 2021

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

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

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

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

Published by:

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

www.gov.uk/environment-agency

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

Email: nuclear@environment-agency.gov.uk

Executive summary

This report covers our Generic Design Assessment (GDA) of General Nuclear System Limited's (GNSL's) submission on gaseous and liquid discharges of radioactive waste for the United Kingdom Hualong Pressurised Reactor design (UK HPR1000) as required in Table 1, Item 5 of our Process and Information Document (P&ID) (Environment Agency, 2016).

Our assessment has considered GNSL's submission in relation to relevant UK policy, legislation and guidance, including Environment Agency's Radioactive Substances Regulation (RSR) Environmental Principles (REPs) (Environment Agency, 2010), the main one being RSMDP12 - Limits and levels on discharges.

Our preliminary conclusions are that:

- GNSL has provided us with information on estimated gaseous and liquid discharges and proposed limits. It is clear how it has derived these discharge estimates and the estimates are supported by suitable evidence
- the proposed annual gaseous and liquid discharge limits for the UK HPR1000 are clearly derived, taking into account our limit setting guidance (Environment Agency, 2012)
- we consider that GNSL has demonstrated that the UK HPR1000 discharges and limits are generally comparable with international OPEX and previous GDAs. Where there are differences, we are satisfied that GNSL has provided reasonable explanations (subject to RQ-UKHPR1000-0843)
- the gaseous and liquid discharges from the UK HPR1000 would be capable of complying with the limits set out below (Tables 1 & 2)

Table 1: Proposed gaseous emission limits for a single unit of the UKHPR1000

Radionuclide	Proposed annual limit (Bq)
Hydrogen-3	5.23E+12
Carbon-14	1.69E+12
Noble gases	1.56E+13
Xenon-133	1.16E+13
Xenon-135	3.45E+12
Halogens	2.21E+08
Other radionuclides	1.12E+07

Table 2: Proposed liquid emission limits for a single unit of the UK HPR1000

Radionuclide	Proposed annual limit (Bq)
Hydrogen-3	1.04E+14
Carbon-14	5.90E+10
Other radionuclides	1.04E+09

During our assessment, we raised one Regulatory Observation (RO) and 5 Regulatory Queries (RQs) related to gaseous and liquid radioactive discharges and proposed limits.

At the time of writing, RQ-UK HPR1000-0843 (see Appendix 2), which is related to previous PWR GDAs remains open. We will assess GNSL's response when it is available.

We have not identified any GDA Issues.

In order to ensure that headroom (that is, the difference between actual discharges and permitted limits) is minimised, we consider the following Assessment Finding to be appropriate:

Assessment Finding 13: A future operator shall keep the headroom factors derived during GDA under review. Operational data generated by the UK HPR1000 should be used to periodically revise the headroom factors to ensure they are minimised as much as possible.

Contents

1. Introduction

This report provides our detailed assessment of GNSL's submission in relation to gaseous and liquid discharges of radioactive waste 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'.

This assessment considers the foreseeable levels of radioactivity in gaseous and liquid radioactive waste discharged to the environment. We have assessed the gaseous and liquid discharges and proposed limits that General Nuclear System Limited (GNSL) provided for its UK HPR1000 design. The assessment aims to establish whether the design could be operated in the UK in line with UK statute, policy and guidance on radioactive waste. It also aims to identify the important issues that should be taken forward into any environmental permit that may be issued with relevant limitations and conditions.

We require new nuclear power plants to use best available techniques (BAT) to prevent and, where that is not practicable, minimise the creation of radioactive waste, and to minimise the impact of discharges of radioactive waste on the environment. We have considered the application of BAT for the UK HPR1000 design in another assessment report (Environment Agency, 2021a).

Our consideration as to the acceptability of proposed discharges has been carried forward into our radiological impact assessment both in terms of impact on members of the public and on wildlife (Environment Agency, 2021c). This allows us to compare the design with the legislative dose limits and dose constraints prescribed for England.

The gaseous and liquid waste treatment systems are also assessed to ensure they represent the best available techniques for minimising production and disposal of radioactive waste (Environment Agency, 2021a).

We have also assessed the non-radioactive discharges from the UK HPR1000; details of this assessment can be found in a separate assessment report (Environment Agency, 2021d).

There are a number of documents in GNSL's submission that were assessed (see Appendix 1).

In this report 'liquid radioactive wastes' refers to aqueous liquid radioactive wastes only, which excludes non-aqueous liquid wastes such as oils. Where reference is made to 'gaseous wastes', these may include some particulates.

We set up an agreement with GNSL to carry out a GDA of the UK HPR1000 design, which came into effect in January 2017. Revision 000-1 of the Pre-Construction Environmental Report (PCER) Chapter 6 - Quantification of Discharges and Limits v0' submission was submitted in November 2018 (GNSL, 2018a) and assessment of this submission and the supporting documents generated a number of Regulatory Queries (RQs) and an RO. A table summarising these and later RQs and ROs is provided in Appendix 2. Subsequent responses to these RQs and RO and discussions at meetings with the Requesting Party (RP) have been incorporated into the later revisions of the 'Quantification of Discharges and Limits' submission, v1 and v1.1 (GNSL, 2020a and b).

In order to help the reader, a summary of the gaseous and liquid discharge routes is provided before the discussion of our assessment.

2. Summary of the gaseous and liquid discharge routes

The gaseous and liquid discharge routes for the UK HPR1000 are quite complex and are outlined in the main submission for this assessment area 'Pre-Construction Environmental Report (PCER) Chapter 6 - Quantification of Discharges and Limits v1.1' (GNSL 2020b). Greater detail on the gaseous and liquid waste management systems can be found in other chapters of GNSL's submission such as 'PCER Chapter 3 - Demonstration of BAT', 'PCER Chapter 4 - Radioactive Waste Management Arrangements' and 'PCER Chapter 8 - Conventional Impact Assessment'. Our understanding of the gaseous and liquid waste management systems has been developed by using all 4 documents. The systems can be summarised as follows.

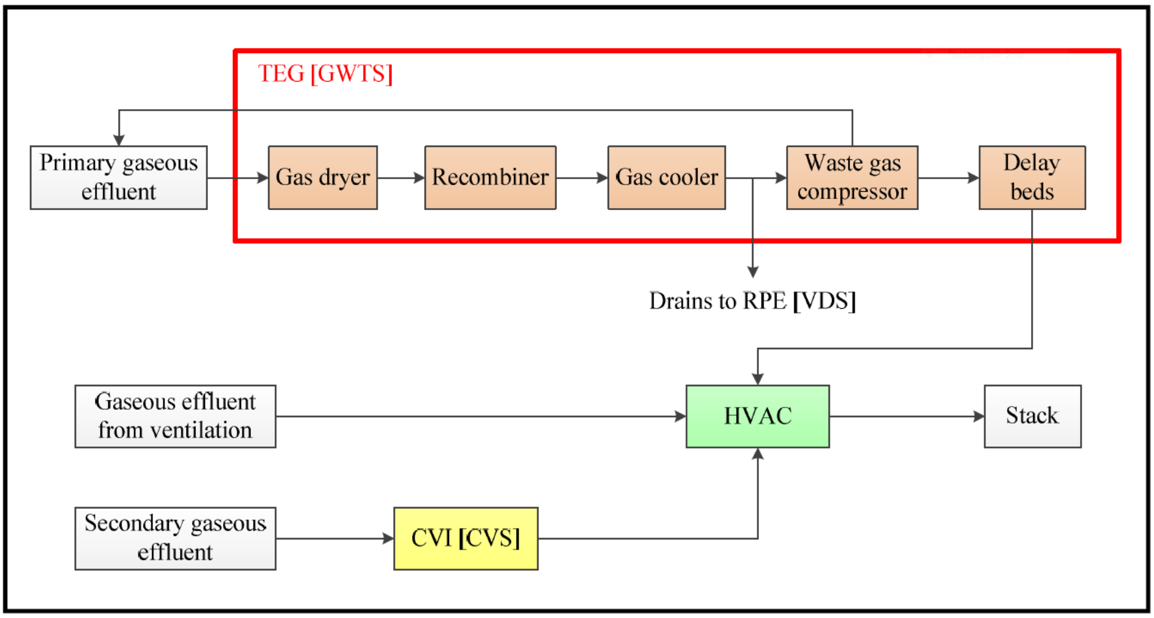
2.1. Gaseous effluent discharge routes

There are 3 main systems that handle gaseous radioactive waste:

- gaseous waste treatment system (GWTS)
- heating ventilation and air-conditioning (HVAC) system - this is made up of a number of sub-systems most notably the 'nuclear auxiliary building ventilation system' (NABVS)
- condenser vacuum system (CVS)

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

Figure 1: Radioactive gaseous effluent streams (GNSL, 2020b, Section 6.4)



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

Primary gaseous effluent comes from the degassing and headspaces of primary coolant or primary effluent vessels. Under normal operation, the GWTS operates as an almost closed loop system with only a small amount of gas going to the delay beds (which allows decay of noble gases). During start-up and shutdown and some maintenance scenarios the system becomes open loop where the gaseous effluents flow to the delay beds rather than being recirculated within the system. After the delay beds, the gas stream discharges into the HVAC system where it is treated by high efficiency particulate air (HEPA) filters before discharge via the main site stack. There is also the option to use iodine traps if deemed necessary.

The gaseous effluents from ventilation arise from the possible leakage from radioactive components inside buildings or from evaporation from the spent fuel pool. This gas stream goes directly to the HVAC system for HEPA filtration.

Secondary gaseous effluent is normally a non-radioactive waste stream. There is, however, a possibility of leakage from the primary to the secondary circuit which would need treatment. This waste stream is, therefore, classed as being a radioactive waste stream and is directed to the HVAC system for HEPA filtration and (if necessary) iodine traps.

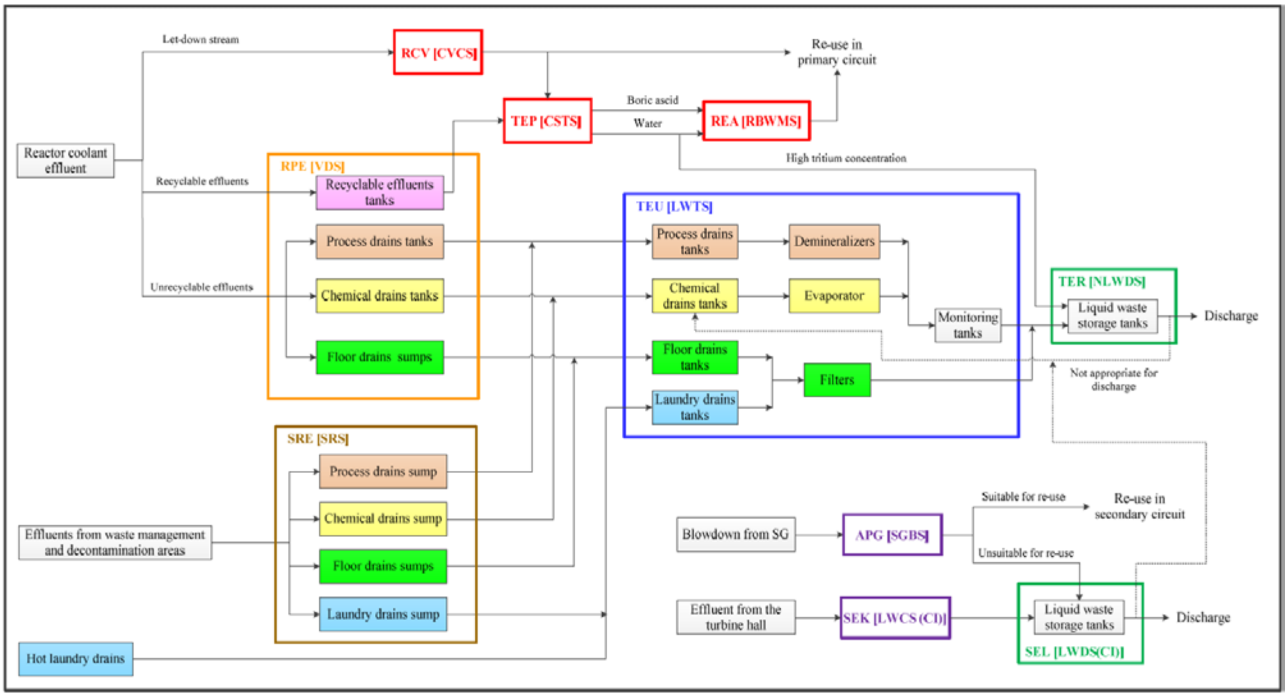
The main site stack is the single emission point for gaseous radioactive waste. The waste stream is monitored continuously to collect data to demonstrate compliance with the discharge limits which will be included in the radioactive substances environmental permit. We assess sampling and monitoring in another assessment report (Environment Agency 2021b)

2.2. Liquid effluent discharge routes

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

The system can be summarised in the following diagram:

Figure 2: Radioactive liquid effluent streams (GNSL, 2020b, Section 6.4)



The liquid waste streams can be divided into 3 categories:

- reactor coolant effluent
- effluents from waste management and decontamination areas
- secondary circuit effluent (steam generator blow-down and turbine hall effluent)

The source of the reactor coolant effluent is from let-down of primary coolant (routed to the 'chemical and volume control system' (CVCS) and drainage and leakage (routed to the 'nuclear island vent and drain system' (VDS)). Some of the reactor coolant effluent is recyclable within the system and this can go back into the primary circuit (unless the treated effluent is unsuitable for re-use where it is routed to the 'nuclear island liquid waste discharge system' (NLWDS)). The non-recyclable reactor coolant effluent stream is collected in process, chemical or floor drains (in VDS) and directed to the liquid waste treatment system (LWTS).

Effluents from waste management and decontamination areas (including hot laundry drains) are collected in process, chemical, floor or laundry drains in the 'sewage recovery system' (SRS) and then treated appropriately in the 'liquid waste treatment system' (LWTS).

The treatment options used in the LWTS are filtration, demineralisation and evaporation. These liquid treatment techniques are consistent with those used widely in similar nuclear power plant. The treatment facilities have been assessed in one of our other assessment reports on the best available techniques for minimising production and disposal of radioactive waste (Environment Agency, 2021a).

The liquid effluent streams described above all flow to the nuclear island liquid waste discharge system (NLWDS) where they are tested before being released to the seal pit then discharged into the environment. If, when tested, the effluent quality is found not suitable for discharge, it can be sent back into the LWTS for additional treatment.

The secondary circuit effluent (steam generator blow-down and turbine hall 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. Any radioactivity would be picked up by the monitoring carried out on the effluent and this would inform the decision to discharge directly to the seal pit and then into the environment (if no detectable radioactive contamination or acceptable levels of chemical contamination are present) or to the LWTS for treatment.

The sampling and monitoring of liquid effluent before it is discharged into the environment is covered in a separate assessment report (Environment Agency 2021b).

3. Assessment

3.1. Assessment method and process

The basis of our assessment was to:

- consider the submissions made by GNSL that make up the 'quantification of discharges and limits' topic area
- hold technical meetings with GNSL to clarify our understanding of the information presented and explain any concerns we had with that information
- raise Regulatory Queries (RQs) to clarify our understanding of the information presented
- raise Regulatory Issues (RIs) or Regulatory Observations (ROs) where we believed GNSL did not provide enough information
- consider the proposed discharges and limits in relation to UK legislation and guidance
- compare them to similar operating plants around the world
- decide on any GDA Issues or other Assessment Findings to carry forward from GDA in our statement of design acceptability (SoDA/iSoDA), if required

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

3.2. Assessment objectives

Important areas of the submission GNSL made under the GDA arrangements for the UK HPR1000 design that we have considered are:

- Are all the sources of gaseous and liquid radioactive waste identified?
- Are all the significant radionuclides relating to gaseous and liquid radioactive waste identified and quantified?
- Are all the assumptions in the submission relating to gaseous and liquid radioactive waste appropriate?
- Have all discharge routes for gaseous and liquid aqueous radioactive waste been identified?
- Have the annual limits proposed by GNSL:
    - been clearly derived?
    - been given acceptable headroom?
    - taken account of our limit setting guidance?
- Do the proposed discharges from the UK HPR1000 exceed those of comparable stations around the world?

3.3. Assessment limitations and scope

This assessment considers gaseous and liquid radioactive waste generated from all aspects of ‘normal operation’, which includes start-up, at power, shutdown, outage and discharges resulting from any other reasonably foreseeable events expected to occur during the lifetime of the reactors (‘expected events’) (Environment Agency, 2012).

This assessment report does not cover gaseous or liquid radioactive waste arising from commissioning or from decommissioning at the end of the reactor life cycle. These phases of the plant life cycle have been agreed to be out of scope of GDA (GNSL, 2019a).

Also out of scope are discharges from the spent fuel interim storage facility, intermediate level waste (ILW) interim storage facility and the low level waste (LLW) buffer store (GNSL, 2019a).

The aspects of the design that are out of scope of GDA will need to be fully assessed at the site-specific stage.

The main legislative areas that have been taken into account are:

- European Commission (EC) Recommendation 2004/2/Euratom, which sets out requirements for monitoring and reporting on radioactive discharges (EC, 2004)
- Environmental Permitting Regulations (EPR 16), which is aimed at controlling radioactive substances, including waste (GB Parliament, 2016)
- statutory guidance to the Environment Agency concerning the Regulation of Radioactive Discharges into the Environment (DECC, 2009)

The requirements of the legislative framework are considered at GDA via our P&ID requirements (Environment Agency, 2016) and our Radioactive Substances Regulation Environmental Principles (REPs) (Environment Agency, 2010).

We published our REPs in 2010 (Environment Agency, 2010). The REP that is most relevant to assessing gaseous and liquid discharges is:

RSMDP12 – Limits and levels on discharges: Limits and levels should be established on the quantities of radioactivity that can be discharged into the environment where these are necessary to secure proper protection of human health and the environment.

3.4. Our assessment

In November 2018 we published our initial assessment findings on GNSL's UK HPR1000 design (Environment Agency, 2018) (https://www.gov.uk/government/publications/new-nuclear-power-stations-initial-assessment-of-general-nuclear-systems-uk-hpr1000-design). After our initial assessment of this topic area, we concluded that in order to carry out our detailed assessment we required the following:

- evidence on the basis for the annual and monthly discharge estimates
- evidence of expected events likely to occur over the lifetime of the plant and clearly show how they have been included in the limit calculations
- a clear method for how the proposed discharge limits are derived
- a comparison of discharges with comparable plants worldwide

In the period between our initial assessment and the time of writing this preliminary detailed assessment report, we have held regular technical meetings with the RP and issued a number of Regulatory Queries (RQs) and one Regulatory Observation (RO). These are summarised in Appendix 2 and will be discussed in the appropriate sections below.

3.4.1. Regulatory context

In its submission, the RP demonstrated a good understanding of the main legislation and guidance that set out our regulatory expectations relating to the quantification of discharges and limits.

3.4.2. Discussion of Regulatory Queries and Regulatory Observation

Very early in the assessment process (April 2018), we raised RQ-UKHPR1000-0076 (see Appendix 2). In this RQ, we asked GNSL to outline the method that it would present for the 'quantification of discharges and limits'. The response GNSL provided was discussed in an Environment Agency/GNSL workshop in April 2018. GNSL outlined the differences between the Chinese and UK approach and confirmed that a method based on operating experience (OPEX) would be developed for GDA. It also outlined GNSL's proposed approach to calculating correction factors and headroom factors.

Based on the information we had at the time, we were satisfied with the response, and GNSL proceeded to develop the first version of 'quantification of discharges and limits', which it submitted in November 2018 (GNSL, 2018a).

During our assessment of the first version of the ‘Pre-Construction Environmental Report’ (PCER), 3 of the supporting documents referenced had not yet been submitted, so we raised RQ-UKHPR1000-0193 in February 2019 to obtain them (see Appendix 2).

After our first full assessment of the PCER and the full set of supporting documents, we identified a number of shortfalls and considered a Regulatory Observation (RO) to be the appropriate way of resolving them. We issued RO-UKHPR1000-0010 in April 2019 and it contained 3 questions relating to OPEX, calculation methodology and data presentation. During the course of the RO resolution, we held regular meetings with the RP, initially to agree the resolution plan and then to assess progress against the agreed plan. The RO was closed in June 2020. The issues raised in the RO and their resolution is summarised as follows.

RO Action 1 - OPEX used for deriving discharge estimates

In our assessment, we noted that the OPEX used was based on the Chinese fleet of predecessor reactor designs. 10 of the 14 reactors chosen had been in operation for less than 5 years and the maximum period of operation was 22 years. Our environmental principle for radioactive substances regulation, RSDMP12 states that 'the process to determine discharge estimates and limits is to be based on a set of data of suitable quality and breadth' (Environment Agency, 2010). The proposed operational life of the UK HPR1000 is 60 years, so we considered the OPEX used initially not to be sufficiently representative. Whilst we considered the total number of years of OPEX GNSL used (52 years) to be a good level of data, our view was that it did not represent the full operational lifetime of a UK HPR1000. We considered it important that the underpinning data for the discharge estimates is justified as being wholly appropriate for the full operational life as the derived proposed limits are used as input data for the radiological assessment, which is then compared against UK dose constraints and legal dose limits (see our assessment report on dose Environment Agency, 2021c).

In its response, GNSL acknowledged that the OPEX initially presented was based on the relatively young Chinese fleet, so representative international plants were selected to improve the data set. Additional OPEX was drawn from the UK, France and Germany. The improved data set was then subjected to trend analysis over a whole plant life time.

A trend analysis of discharges representative of the full 60-year life of a UK HPR1000 based on a wider set of OPEX was presented in a document that was created specifically in response to this RO (GNSL, 2019d).

We assessed the trend analysis document and found that the additional OPEX selected and trend data presented were considered to sufficiently demonstrate how discharges could vary throughout the 60-year life of a UK HPR1000. The document concludes that, for the data set presented, there is no notable increase in radioactive discharges due to plant ageing and, therefore, the Chinese fleet OPEX presented originally can be demonstrated to be representative of the full operational lifetime of the plant.

RO Action 2 - Calculation method used for deriving discharge limits

We noted that the method used to calculate the discharge estimates did not fully align with our limit setting guidance (Environment Agency, 2012) in so far as it wasn't clear how 'expected events' had been included in the calculations. Expected events are those operational fluctuations that can be reasonably expected to occur during the operational life of the plant and are considered to be part of 'normal operation' for deriving discharge estimates. We would then expect a headroom factor to be applied to account for the operational variability and uncertainty in the underpinning data when deriving discharge limits. We asked the RP to revise its calculations to clearly show expected events being part of 'normal operation' and to minimise the headroom factor applied so it only covered variability and uncertainty in the underpinning data.

In response to the RO Action, GNSL revised an existing supporting document on the 'Estimation of Radioactive Gaseous Discharges and Limits for the UK HPR1000' (GNSL 2019b). GNSL applied a new approach and revised its calculations to present annual discharges, headroom and expected events as individual elements of the calculations. This is more in line with our limit setting guidance (Environment Agency 2012) and the P&ID requirement (Environment Agency 2016).

The revised document ‘Estimation of Radioactive Gaseous and Liquid Discharges and Limits for UK HPR1000’ (GNSL, 2019b) was assessed and we found that the presentation of the headroom factor and expected event calculations had been improved from the previous approach.

RO Action 3 - Data presentation in accordance with the P&ID requirements

Our P&ID information requirement is that each constituent of normal operation should be clearly stated. These are:

- routine operation
- start-up and shutdown
- maintenance and testing
- expected events

At the time of the RO, the average and maximum monthly discharges had been calculated, but we could not see how each of the above constituents had fed into the calculation. We also asked the RP to acknowledge the variation in discharges that occur during both operation and outage and ensure they are defined separately in the calculations.

In its response, GNSL agreed to adjust the way its discharge estimates are calculated and presented in the relevant documents.

The revised approach required GNSL to revise 2 documents (GNSL 2019b) and (GNSL 2019c), which were submitted and assessed.

The revisions provided better clarity on the individual elements that constitute the discharge estimates. The calculations that ultimately produce the discharge estimates and limits could now be followed in enough detail to carry out a fuller assessment. The approach was considered sufficient for GDA.

When we had fully assessed the revised and newly created documents that described the quantification of discharge estimates and limits, we found it necessary to clarify a number of points and issued RQ-UKHPR1000-0679 in March 2020 (See Appendix 2).

In RQ-UKHPR1000-0679 (see Appendix 2), we asked whether the headroom factors would be reviewed using real data throughout the life of the plant to ensure they are minimised as much as possible. In its response, GNSL stated that it had demonstrated in its trend analysis document (GNSL 2020d) that discharges are expected not to increase (and, in many cases, decrease) throughout the operational life of the UK HPR1000, so the headroom factors derived at GDA represent a bounding case. While we accept this conclusion for GDA, it is still important that a future operator ensures that the variability assumed at GDA is periodically updated using real data generated by a UK HPR1000 throughout the life of the plant.

In its supporting document on estimating discharges and limits, GNSL used a split of 10 months' operation and 2 months' outage. In RQ-UKHPR1000-0679 (see Appendix 2), we also asked GNSL to explain its rationale behind this approach. In its response, GNSL confirmed that despite shutdown for refuelling taking place approximately every 18 months, it considers the 10 month/2 month split used in its estimates to be a realistic bounding case to ensure the peak in discharges generated during an outage is captured in annual discharge estimates and limits. The 2-month duration is based on OPEX and covers preparatory activities, maintenance and testing and the refuelling itself.

In RQ-UKHPR1000-0679, we also asked GNSL to clarify why the expected events had not been separated into those that can happen only during operation or outage. In its response, GNSL confirmed that it was not considered appropriate to separate them because, apart from unplanned shutdown, all the identified expected events could occur during either operation or outage. GNSL also considered them difficult to separate because there may be some delay between the event and any release to the environment due to transportation through the system and decay as it does so.

Despite Assessment Finding 13 (see below under heading 'Deriving headroom factors'), we consider the responses to the RO and the subsequent RQ to be satisfactory and we formally closed out the RO in June 2020. Having successfully completed the work associated with the RO, we are now able to summarise GNSL's method for quantifying discharges and limits and present our preliminary conclusions on each element.

3.4.3. Our assessment of GNSL's method for quantifying discharges and limits

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

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

The method is outlined in 'PCER Chapter 6 - Quantification of Discharges and Limits' (GNSL, 2020b), but the RP has produced several supporting documents to provide the detail that underpins the content of the PCER Chapter 6 (see Appendix 1).

Definition of operating conditions

GNSL defines the operating conditions used for quantifying discharges and limits as:

- routine operation

- start-up and shutdown
- maintenance and testing
- expected events

GNSL's approach was to source its data from OPEX rather than theoretically deriving it from a source term calculation. This meant it was not possible to separate out each of the above aspects as required by the P&ID (Environment Agency, 2016). GNSL's approach was to include routine operation, start-up and shutdown and maintenance and testing as one of two operational states, either 'power operation' or 'shutdown'. GNSL has stated in 'Estimation of Radioactive Gaseous and Liquid Discharges and Limits for UK HPR1000' (GNSL 2019b) that 'power operation' includes routine operation and maintenance and testing carried out when the plant is generating power, and 'shutdown' includes shutdown, discharges during preparatory activities and refuelling, maintenance and testing carried out during outage and start-up'. We understand the difficulties GNSL would have separating out each element from the OPEX and we are satisfied that the main intent of the requirements of the P&ID have been captured in the data. We therefore accept GNSL's approach as being acceptable for GDA.

Expected events are presented as a distinct element throughout the calculations (see 'Deriving appropriate expected events' below).

Identifying significant radionuclides

GNSL has used our guidance on limit setting (Environment Agency, 2012) to help define a set of 'significant radionuclides'. The approach defines significant radionuclides as those which:

- are significant in terms of radiological impact on people (the dose to the most exposed group at the proposed limit exceeds 1µSv/yr)
- are significant in terms of radiological impact on wildlife (the impact on reference organisms from the discharge of a single radionuclide at the proposed limit exceeds 10µGy/hr)
- are significant in terms of quantity of radioactivity discharged (the discharge of a radionuclide exceeds 1TBq/yr)
- may contribute significantly to the collective dose - where the collective dose (truncated at 500 years from the discharges of all radionuclides at the proposed limits) exceeds one man-Sievert per year to any of the UK, European or world populations
- are constrained under national agreements or are of concern internationally
- are indicators of plant performance
- are not covered by the limits set in the above criteria but which require a limit under a generic category (such as 'alpha particulate' or 'beta/gamma particulate')

GNSL applied the criteria and presented its findings in both the 'Quantification of Discharges and Limits' (GNSL, 2020b) and the 'Estimation of Radioactive Gaseous and Liquid Discharges and Limits for UK HPR1000' (GNSL, 2019c) documents. The following table shows which radionuclides or groups of radionuclides have been identified by GNSL under each criterion.

Table 4: Significant radionuclides identified by GNSL for the UK HPR1000 design (GNSL, 2020b, section 6.5.2)

Selection criteria	Gaseous discharge	Liquid discharge
Dose to most exposed person (>1µSv/yr)	Carbon-14	Carbon-14
Dose to non-human species (greater than 10µGy/hr for exposure from a single source)	-	-
Discharged activity (greater than 1TBq)	Hydrogen-3, carbon-14, xenon-133, xenon-135	Hydrogen-3
Collective dose (greater than 1 man.Sv)	Carbon-14	-
Plant performance indicators	Xenon-133, xenon-135 (fuel reliability indicators) Other beta/gamma emitters (performance of gaseous waste management system)	Other gamma emitters (performance of liquid waste management system)

It is worth noting that for dose to non-human species 10µGy/hr has been used for GDA rather than 40µGy/hr as stated in our limit setting guidance (Environment Agency, 2012). We advise the use of 40µGy/hr for the impact on the receptor (that is, species or habitat) from all sources of radioactive discharges that have a pathway to that receptor. This level is appropriate where we know the location and any other radioactive discharges that may affect the receptor(s). For GDA, we advise a lower level of 10µGy/hr because GDA is based on a single unit at an unknown location with the possibility that the location could be adjacent to other sources of radioactive discharges. The figure GNSL used is therefore considered to be correct.

We consider the radionuclides selected as significant to be appropriate for the purposes of GDA.

Deriving correction factors

GNSL has based the estimation of discharges and therefore proposed limits on OPEX. The selection of OPEX data is detailed in a supporting document 'OPEX Data Selected for Quantification of Discharges and Limits for UK HPR1000' (GNSL, 2019c) and summarised throughout the main ‘Pre-Construction Environmental Report Document - Quantification of Discharges and Limits’ (GNSL, 2020b). GNSL selected OPEX data from plants similar in design to the UK HPR1000, however there are some design differences that could affect the discharge estimates. Correction factors were derived as a way of reducing the impact of any differences on the discharge estimates for the UK HPR1000. GNSL considered the applicability of correction factors for all the significant radionuclides and concluded that a correction factor was only appropriate for hydrogen-3 and carbon-14 in both gaseous and liquid discharges. Hydrogen-3 is affected by power differences between the UK HPR1000 and OPEX units. Carbon-14 is also affected by power differences, but will also be higher in the UK HPR1000 than in OPEX plants because the UK HPR1000 uses nitrogen as a cover and purge gas instead of hydrogen, which is used in the Chinese fleet OPEX. Hydrogen is a flammable gas and poses an explosion risk, so nitrogen has been selected as an alternative for the UK HPR1000 design (Environment Agency, 2021a). Nitrogen does, however, dissolve in the coolant and nitrogen-14 can be activated to form carbon-14. Nitrogen-14 in the primary coolant contributes about 12% of the carbon-14 production from the UK HPR1000. This is assessed in more detail in our assessment report 'Best available techniques for minimising production and disposal of radioactive waste (Environment Agency, 2021a).

We are content that GNSL's conclusions and methods for calculating correction factors seem reasonable.

Deriving headroom factors

Headroom factors are important to take account of the uncertainty in the OPEX data used to derive the discharge limits. They allow a future operator to comply with the proposed limits without unduly affecting its ability to operate the plant. We acknowledge in our limit setting guidance (Environment Agency, 2012) that '…there may be considerable uncertainty about the data presented in the application….and hence limits for new plants will, in general, provide for greater headroom than operational plants where discharge data are available. We would review limits against operating data, when available.' To ensure that the bounding case derived for GDA is continually revised as the design of the plant advances and operation begins, and so that headroom is the minimum necessary to permit normal operation, we consider the following Assessment Finding to be appropriate:

Assessment Finding 13: A future operator shall keep the headroom factors derived during GDA under review. Operational data generated by the UK HPR1000 should be used to periodically revise the headroom factors to ensure they are minimised as much as possible.

GNSL carried out a statistical analysis of the OPEX data and adopted a conservative approach of a one-sided normal distribution to quantify headroom. This provided a 99.9% confidence level over the 60-year lifetime of the plant. Headroom factors were calculated for all significant radionuclides.

We are content that GNSL's conclusions on headroom factors for all significant radionuclides are appropriate for GDA, however they will be periodically reviewed throughout the life of the plant (see Assessment Finding 13).

Deriving appropriate expected events

GNSL carried out a process to identify expected events and then quantify their contribution to the discharge estimates (in terms of Bq). Expected events for the UK HPR1000 have been derived in 2 supporting documents 'Methodology for Expected Events Identification for UK HPR1000' (GNSL, 2019f) and 'Expected Event List for UK HPR1000' (GNSL, 2019g). We were kept up to date on progress with this process in our regular meetings with the RP.

The process involved determining a preliminary set of expected events for each radionuclide group. A number of experts in a range of design areas from CGN, GNSL, EDF, Sizewell B and Hinkley Point C were then consulted with the list. This consultation was carried out via workshops, meetings or written reviews until a consensus was reached on the final list. We considered this to be an important step to validate the outcomes of the theoretical assessment process with expert judgement. Once the final list was established, a bounding case was developed for each significant radionuclide, taking into account reasonable occurrences of the expected events. This resulted in a contribution (in Bq) that could be used in calculating the annual limits for each significant radionuclide (see 'estimated discharges and proposed limits' below). Additional detail on the process and the final expected event list is presented by GNSL in its supporting document 'Expected Event List for UK HPR1000' (GNSL, 2019g). The final list of expected events is displayed in Table 5.

Table 5: Expected event list for UK HPR1000 (GNSL, 2019g)

Radionuclide group	Expected event
Hydrogen-3	Unplanned shutdown
	Increase of the open water evaporation due to temperature, air velocity or humidity changes
	Small leak of the radioactive systems
Carbon-14	Increase of nitrogen concentration in primary coolant
Noble gases	Fuel pin cladding defect
	Unplanned shutdown
	Small leak of the radioactive systems
	Small leak from the primary side to the secondary side
Halogens	Fuel pin cladding defect
	Unplanned shutdown
	Failure or low efficiency of the iodine traps of HVAC system
	Failure of the online monitoring of HVAC before the iodine traps
	Failure of evaporation unit or demineralisation unit of the liquid waste treatment system
	Small leak of the radioactive systems
	Small leak from the primary side to the secondary side
Other radionuclides	Fuel pin cladding defect
	Unplanned shutdown
	Failure of evaporation unit or demineralisation unit of the liquid waste treatment system
	Failure of pre-filters or HEPA filters of HVAC system
	Contamination of primary coolant
	Small leak of the radioactive systems
	Small leak from the primary side to the secondary side

Note - 'Noble gases' are radioactive isotopes of krypton, argon and xenon. 'Halogens' are radioactive isotopes of iodine and bromine. 'Other radionuclides' contain a range of radioactive isotopes, which include caesium, barium and strontium.

As part of our assessment of the expected event list, we reviewed the GNSL document 'Secondary Coolant Source Terms Supporting Report' (GNSL, 2019e). We would have expected this document to have been linked to the ‘Discharge Estimates’ document (GNSL, 2019b) because 2 of the expected events identified in Table 5 above ('small leak from the radioactive systems' and ‘small leak from the primary circuit to secondary circuit') are considered likely to affect the secondary circuit. We could not identify where the impact of such leaks had been incorporated into the discharge estimate and limit calculations.

We also noted that carbon-14 was not mentioned in the secondary coolant source term document (GNSL, 2019e). In order to answer these questions, we raised RQ-UKHPR1000-678. In its response, GNSL confirmed that the secondary source term in this document was derived from the primary source term by theoretical calculation and does not use OPEX. The secondary source term presented in this document is for carrying out radiological protection calculations, which ONR assessed separately. GNSL also confirmed that the 2 expected events ('small leak from the radioactive systems' and 'small leak from the primary side to secondary side') would be very small in terms of radioactivity and are included in the OPEX data. For these reasons, GNSL considered it not appropriate to include it in the secondary source term.

We agree with the conclusions GNSL reached.

In response to the other query in RQ-UKHPR1000-0678, GNSL confirmed that, as the main purpose of the secondary source term document (GNSL, 2019e) is for shielding design, carbon-14 (a low energy beta emitter) does not need to be included because it does not affect the shielding design.

Summary of our assessment of GNSL's method for quantifying discharges and limits

In summary, we consider the methods GNSL used and the conclusions it reached in establishing operating conditions, significant radionuclides, correction factors, headroom factors and contributing expected events to be reasonable.

3.4.4. Estimated discharges and proposed limits

Once the various factors described in section 3.4.3 above had been established, GNSL used them in a series of calculations, along with OPEX, to determine discharge estimates and proposed limits. The specific outputs of the calculations are as follows:

- estimated monthly discharges
- estimated annual discharges

These estimates were then used to calculate:

- annual discharge limits

Calculations are also presented to derive maximum monthly discharge estimates. These provide an indication of possible variation in short term discharges during normal operation which would remain within specific annual limits. These can be caused by expected events and variation in plant parameters – leading to short term increases in discharges which can potentially affect the radiological impact. The maximum monthly discharges presented are used solely as an input to the radiological impact assessment – which is included in 'PCER Chapter 7 - Radiological Assessment'. Our view on this assessment is presented in a separate assessment report. (Environment Agency, 2021c).

GNSL's calculation of annual discharge limits involved establishing the estimated monthly discharges for power operation and shutdown and then using these to calculate the estimated annual discharges. The headroom factor and contribution of expected events, along with the estimated annual discharges, were then used to calculate a proposed annual limit for each significant radionuclide (see Tables 6 & 7 below).

We have assessed the calculations used to derive discharge estimates and proposed limits presented in Chapter 6 of the 'Pre-Construction Environmental Safety Report' (GNSL, 2020b) and the supporting document 'Estimation of Radioactive Gaseous and Liquid Discharges and Limits for the UK HPR1000' (GNSL, 2019b). We are satisfied that they satisfy the requirements of our limit setting guidance (Environment Agency, 2012) and cover the requirements of the P&ID (Environment Agency, 2016). The estimated discharges and proposed limits are shown in Tables 6 and 7 below.

Table 6: Gaseous - Estimated discharges and proposed limits

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

Table 7: Liquid - Estimated discharges and proposed limits

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

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

As required by our P&ID, GNSL has carried out a comparison of the discharge estimates and proposed limits derived above with other similar reactors worldwide. The comparison is presented in both the main ‘Pre-Construction Environmental Report’ Chapter 6 (GNSL, 2020b) and the supporting document on ‘Estimation of Discharges and Limits’ (GNSL, 2019b). GNSL approached this by carrying out a comparison with previous PWR GDAs and then with other international OPEX (UK, France, Germany & USA).

Important points to consider are:

- Comparisons with both previous GDAs and international OPEX involve using data 'normalised to 1,000MWe'. This is an acceptable approach as it enables as meaningful a comparison as possible to be carried out. For example, discharges of hydrogen-3 and carbon-14 are both proportional to power output, so normalising the data to 1,000MWe enables these radionuclides to be compared.
- Comparison with international OPEX is comparing conservatively derived estimates for the UK HPR1000 with actual discharges.

Comparison with previous PWR GDAs

GNSL reviewed the publicly available information on the previous GDAs for the UK EPR and the UK AP1000. Acknowledging the difference in methods for quantifying discharges and limits used by the 3 RPs, GNSL carried out an indicative comparison of the data normalised to 1,000MWe. GNSL produced graphs of the results and they are reproduced in Appendix 3.

The graphs show that for all radionuclides, except gaseous hydrogen-3, carbon-14 and liquid hydrogen-3 the UK HPR1000's discharges are the same or slightly lower than the other PWRs.

Where the UK HPR1000 discharges are slightly higher (gaseous hydrogen-3, carbon-14 and liquid hydrogen-3), GNSL has explained that this is likely to be due to the varying assumptions made between the 3 GDAs. GNSL initially cited the different approaches as being specifically due to headroom factors and expected events. We considered that better justification was necessary and issued RQ-UKHPR1000-0843 to request this. The RQ remains open at the time of writing and we will assess the response when we receive it.

Comparison with international OPEX

In order to make a meaningful comparison, GNSL took the annual averages from the international OPEX and the annual discharge estimates from the UK HPR1000 and then normalised them to 1,000MWe. GNSL produced graphs of the results and they are reproduced in Appendix 4.

The graphs in appendix 4 show that the UK HPR1000 annual discharges are broadly similar to the international OPEX from similar plants around the world. The OPEX data selected is based on annual averages and is described in detail in the supporting document 'OPEX data selected for quantification of discharges and limits for UK HPR1000' (GNSL, 2019c). In both the main ‘Pre-Construction Environmental Report’ Chapter 6 (GNSL, 2020b) and the supporting document on ‘Estimation of Discharges and Limits’ (GNSL, 2019b) GNSL provided the following considerations and conclusions.

GNSL considerations:

- GNSL has calculated its discharges based on 10 months of power operation and 2 months of outage to ensure both operational and outage phases are captured in the annual figures. When compared to actual OPEX, where most plants use an 18-month refuelling cycle, the UK HPR1000 annual discharges can be considered to be overestimated.
- Differences in reporting approaches in different countries could have resulted in the UK HPR1000 figures being overestimated by comparison with certain countries. The UK, France and China have an approach that involves reporting half of the detection limit when the result obtained is below detection limit. The UK HPR1000 also uses this approach. In contrast, in the USA and Germany, measurements below detection limits are not reported.
- The UK HPR1000 uses nitrogen as a cover and purge gas. This has been driven by safety considerations to replace hydrogen gas (which has a risk of explosion) with nitrogen gas. Gaseous carbon-14 is generated from the activation of nitrogen gas. This approach mirrors that adopted at the German plants and the UK EPR design at Hinkley Point C. GNSL therefore expects actual discharges to be closer to the German plants but higher than those that use hydrogen as the cover and purge gas.

GNSL conclusions:

- Gaseous carbon-14 from the UK HPR1000 design is slightly higher than comparable plants that use hydrogen as the cover and purge gas.
- Gaseous discharges of hydrogen-3, noble gases, halogens and other radionuclides are generally comparable (higher than some, lower than others) to other plants. GNSL cites the likelihood that some UK HPR1000 figures could be overestimated (see 'GNSL considerations above).
- The liquid annual discharge of other radionuclides (which includes carbon-14) is slightly higher than comparable plants that use hydrogen as the cover and purge gas.

We consider the information GNSL provided in this section demonstrates that the UK HPR1000 discharges and limits are generally comparable with international OPEX and previous GDAs. Where there are differences, we are satisfied that GNSL has provided reasonable explanations (subject to the outstanding RQ response).

3.5. Compliance with Environment Agency requirements for GDA

Compliance with Environment Agency requirements for GDA are summarised in Table 8 below.

Table 8: Compliance with Environment Agency requirements for GDA

Requirements from P&ID and REPs	Comments
P&ID Table 1, item 5	GNSL has provided estimates of aqueous radioactive waste disposals for normal operation and proposed limits for the disposal of aqueous radioactive waste.
RSDMP12	GNSL has proposed limits for the UK HPR1000 gaseous and liquid waste disposals.

4. Public comments

GNSL received no public comments up to 30 June 2020 concerned directly with quantifying discharges and limits.

5. Conclusion

We have reviewed the assessment objectives and our preliminary conclusions are that:

- GNSL has provided us with information on estimated gaseous and liquid discharges and proposed limits. It is clear how it has derived these discharge estimates and the estimates are supported by suitable evidence
- the proposed annual gaseous and liquid discharge limits for the UK HPR1000 are clearly derived, taking into account our limit setting guidance
- we consider that GNSL has demonstrated that the UK HPR1000's discharges and limits are generally comparable with international OPEX and previous GDAs. Where there are differences, we are satisfied that GNSL has provided reasonable explanations (subject to RQ-UKHPR1000-0843)

- the gaseous and liquid discharges from the UK HPR1000 would be capable of complying with the limits set out below (Tables 9 and 10):

Table 9: Proposed gaseous and emission limits for the UK HPR1000

Radionuclide	Proposed annual limit (Bq)
Hydrogen-3	5.23E+12
Carbon-14	1.69E+12
Noble gases	1.56E+13
Xenon-133	1.16E+13
Xenon-135	3.45E+12
Halogens	2.21E+08
Other radionuclides	1.12E+07

Table 10: Proposed liquid emission limits for the UK HPR1000

Radionuclide	Proposed annual limit (Bq)
Hydrogen-3	1.04E+14
Carbon-14	5.90E+10
Other radionuclides	1.04E+09

However, our preliminary conclusions are subject to an open RQ (RQ-UK HPR1000-0843), which will be assessed when the information has been received.

We considered the following Assessment Finding to be appropriate:

Assessment Finding 13: A future operator shall keep the headroom factors derived during GDA under review. Operational data generated by the UK HPR1000 should be used to periodically revise the headroom factors to ensure they are minimised as much as possible.

References

Author	Reference
BERR. 2008	'Meeting the Energy Challenge. A White Paper on Nuclear Power' BERR 2008 http://webarchive.nationalarchives.gov.uk/20100512172052/http:/www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/white_paper_08/white_paper_08.aspx
DECC. 2009	'Statutory Guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment' Department of Energy and Climate Change and Welsh Assembly Government, 2009 http://webarchive.nationalarchives.gov.uk/20121217150421/http:/decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/nuclear/radioactivity/dischargesofradioactivity/1_20091202160019_e_@@_guidanceearadioactivedischarges.pdf
GB Parliament. 2016	'The Environmental Permitting (England and Wales) Regulations 2016' SI 2016 No. 1154, as amended https://www.legislation.gov.uk/uksi/2016/1154/contents/made
EC. 2004	'EU Commission Recommendation 2004/2/Euratom of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation' https://ec.europa.eu/energy/sites/ener/files/documents/2004_2_en.pdf
Environment Agency. 2010	'Regulatory Guidance Series, No RSR 1. Radioactive Substances Regulation – Environmental Principles' Environment Agency, 2010 https://www.gov.uk/government/publications/radioactive-substances-regulation-environmental-principles
Environment Agency. 2012	'Criteria for setting limits on the discharge of radioactive waste from nuclear sites' Environment Agency, 2012 https://www.gov.uk/government/publications/discharge-of-radioactive-waste-from-nuclear-sites-setting-limits
Environment Agency. 2016	'Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs' (Environment Agency, version 3, October 2016)

Author	Reference
Environment Agency. 2018	‘Initial assessment of General Nuclear System’s UK HPR1000 design: Statement of findings’ Version 1, 2018 https://www.gov.uk/government/publications/new-nuclear-power-stations-initial-assessment-of-general-nuclear-systems-uk-hpr1000-design
Environment Agency. 2021a	‘Preliminary detailed assessment of best available techniques for minimising production and disposal of radioactive waste for General Nuclear System’s UK HPR1000 - AR03’
Environment Agency. 2021b	‘Preliminary detailed assessment of monitoring of discharges and disposals of radioactive waste for General Nuclear System’s UK HPR1000 - AR06’
Environment Agency. 2021c	‘Preliminary detailed assessment of generic site and impact of radioactive discharges for General Nuclear System’s UK HPR1000 - AR07’
Environment Agency. 2021d	‘Preliminary detailed assessment of other environmental regulations for General Nuclear System’s UK HPR1000 - AR08’
GNSL. 2018	‘Pre-Construction Environmental Report Chapter 6 - Quantification of Discharges and Limits’ HPR/GDA/PCER/0006, Rev. 000-1, November 2018 (V0)
GNSL. 2019a	‘Scope for UK HPR1000 GDA project’ HPR-GDA-REPO-0007 Rev 001 July 2019
GNSL. 2019b	‘Estimation of Radioactive Gaseous and Liquid Discharges and Limits for UK HPR1000’ GHX35000002DNFP03GN, Rev E, November 2019
GNSL. 2019c	‘OPEX Data Selected for Quantification of Discharges and Limits for UK HPR1000’ GHX35000001DNFP03GN, Rev D, November 2019
GNSL. 2019d	‘Trend Analysis of Radioactive Discharges of Nuclear Power Plant during whole life-time’ GHX35000003DNFP02GN, Rev B, November 2019
GNSL. 2019e	‘Secondary Coolant Source Term Supporting Report’ GHX90300004DNFP03GN, Rev B, August 2019
GNSL. 2019f	‘Methodology for Expected Events Identification for UK HPR1000’ GHX00500001DNHX02GN, Rev B, March 2019

Author	Reference
GNSL. 2019g	‘Expected Event List for UK HPR 1000’ GHX00500001DNFP02GN, Rev D, September 2019
GNSL. 2020a	Pre-Construction Environmental Report Chapter 6, - Quantification of Discharges and Limits’ HPR/GDA/PCER/0006, Rev. 001, January 2020 (V1)
GNSL. 2020b	Pre-Construction Environmental Report Chapter 6 - Quantification of Discharges and Limits’ HPR/GDA/PCER/0006 Rev.001-1 October 2020 (V1.1)

Abbreviations

Acronym	*Meaning*
AF	Assessment Finding
ALARA	As low as reasonably achievable
BAT	Best available techniques
CGN	Chinese General Nuclear
EC	European Commission
EDF	Électricité De France
EPR	Environmental Permitting Regulations
HEPA	High efficiency particulate air (filter)
GDA	Generic design assessment
GNSL	General Nuclear System Limited
HVAC	Heating, ventilation and air conditioning
LLW	Low level waste
ILW	Intermediate level waste
iSoDA	Interim statement of design acceptability
OPEX	Operating experience
P&ID	Process and Information Document
PCER	Pre-Construction Environmental Report
PWR	Pressurised water reactor
REPS	Radioactive Substances Regulation - Environmental Principles
RO	Regulatory Observation

Acronym	*Meaning*
RP	Requesting Party
RQ	Regulatory Query
SoDA	Statement of design acceptability
UK	United Kingdom

Appendix 1: GNSL documentation

Table 3: GNSL documentation reviewed for this assessment

Title	Document no.
Pre-Construction Environmental Report, Chapter 6 - Quantification of Discharges and Limits v0	HPR/GDA/PCER/0006, Rev. 000-1, November 2018
Pre-Construction Environmental Report, Chapter 6 - Quantification of Discharges and Limits v1	HPR/GDA/PCER/0006, Rev. 001, January 2020
Pre-Construction Environmental Report, Chapter 6 - Quantification of Discharges and Limits v1.1	HPR/GDA/PCER/0006 Rev.001-1 October 2020
Scope for UK HPR1000 GDA project v1	HPR-GDA-REPO-0007 Rev 001 July 2019
Estimation of Radioactive Gaseous and Liquid Discharges and Limits for UK HPR1000	GHX35000002DNFP03GN, Rev E, November 2019
OPEX Data Selected for Quantification of Discharges and Limits for UK HPR1000	GHX35000001DNFP03GN, Rev D, November 2019
Trend Analysis of Radioactive Discharges of Nuclear Power Plant during whole life-time	GHX35000003DNFP02GN, Rev B, November 2019
Secondary Coolant Source Term Supporting Report	GHX90300004DNFP03GN, Rev B, August 2019
Methodology for Expected Events Identification for UK HPR1000	GHX00500001DNHX02GN, Rev B, March 2019
Expected Event List for UK HPR 1000	GHX00500001DNFP02GN, Rev D, September 2019

Appendix 2: Summary of Regulatory Queries and Observations relating to quantification of discharges and limits

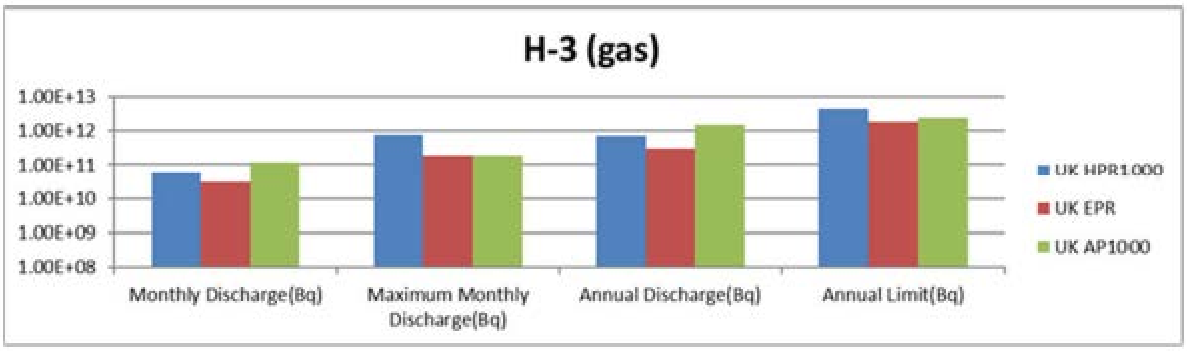
The following table summarises the RQs and ROs that are most relevant to the quantification of discharges and limits for the UK HPR1000 (There are no Regulatory Issues [RIs] relevant to this topic area).

RQ/RO/RI	Date issued	Title and summary
Regulatory Queries		
RQ-UKHPR1000-0076	03-April-2018	Provenance and validity of discharge estimates • GNSL was requested to provide further information on its proposed method for deriving discharge estimates.
RQ-UKHPR1000-0193	04-Feb-2019	Reference request - expected event methodology • GNSL was asked to provide information on its expected events method.
RQ-UKHPR1000-0678	13-Mar-2020	Secondary coolant source term • GNSL was requested to provide clarification on why leakage from the primary to secondary side was not clearly highlighted in the discharge estimate calculations and also why carbon-14 did not feature in the secondary source term report.
RQ-UKHPR1000-0679	13-Mar-2020	RO-10 clarification • GNSL was asked to clarify some points relating to its response to RO-UKHPR-1000-0010.
RQ-UKHPR1000-0843	09-Jun-2020	Comparison of radioactive discharges with other nuclear power plants • GNSL was asked to provide better justification for its conclusions on the comparison between UK HPR1000 and previous PWR GDAs.
Regulatory Observations		
RO-UKHPR1000-0010	12-Apr-2019	Discharge estimates and limits GNSL was asked to carry out further work to: • demonstrate that OPEX used are representative of a full operational plant life

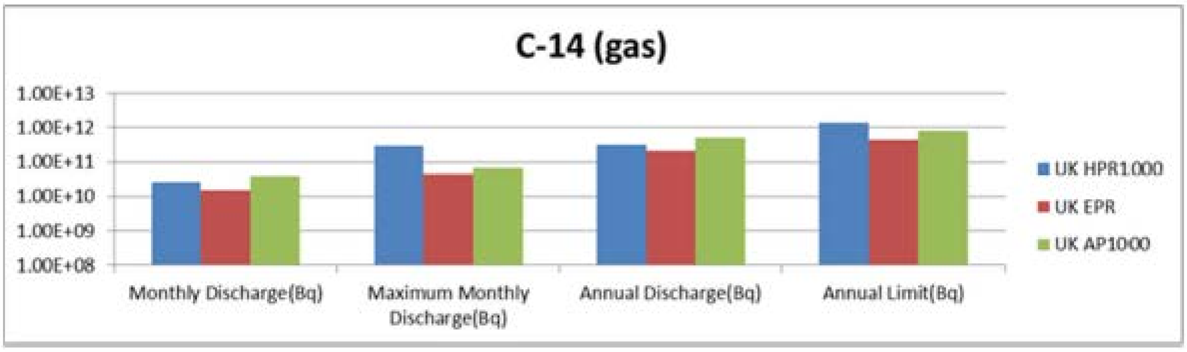
RQ/RO/RI	Date issued	Title and summary
		• demonstrate that the calculations are in line with Environment Agency guidance • clearly show each constituent part of normal operations used to calculate the discharge estimates

Appendix 3 - Graphs showing comparison with previous PWR GDAs

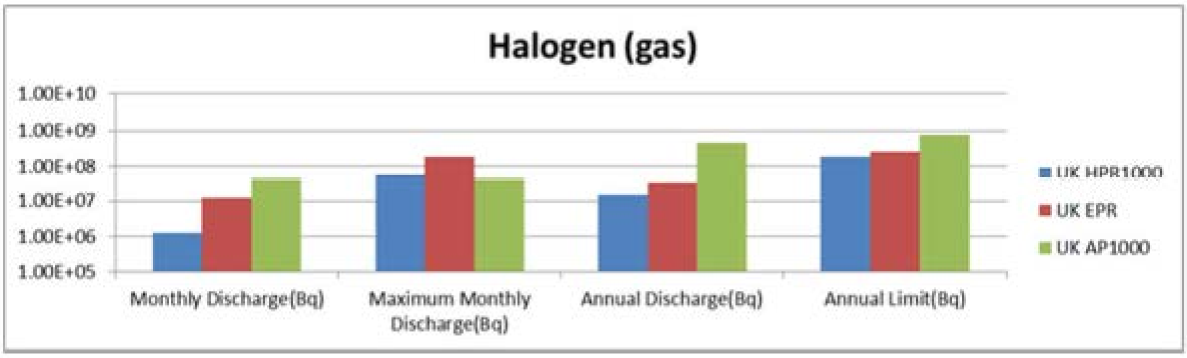
NOTE - all data used in the graphs are normalised to 1,000MWe to enable meaningful comparison (see section 3.4.5 above).



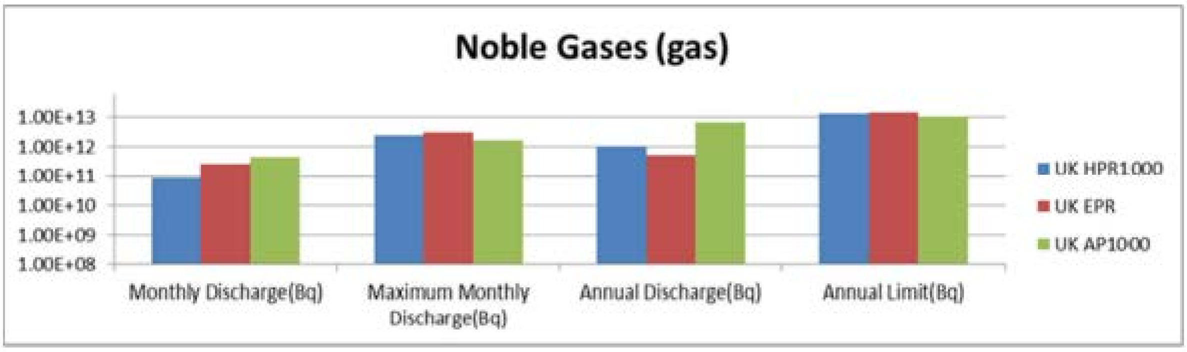
Gaseous - Hydrogen-3 - comparison of discharges and limits



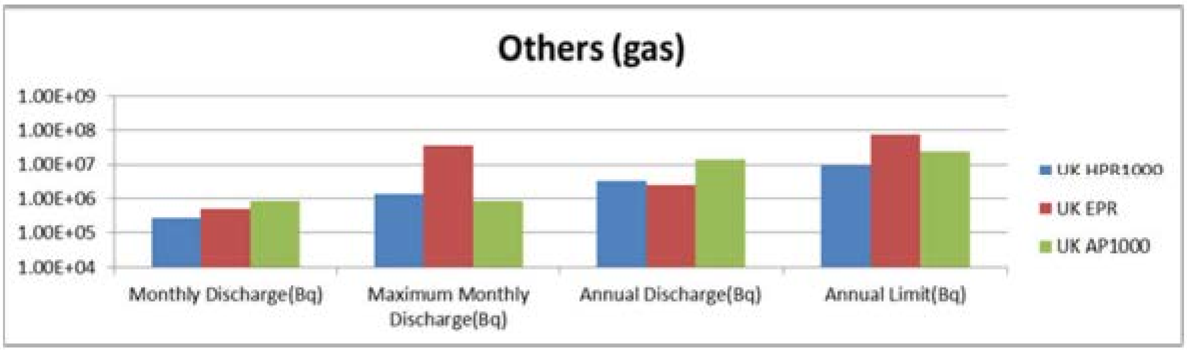
Gaseous - Carbon-14 - comparison of discharges and limits



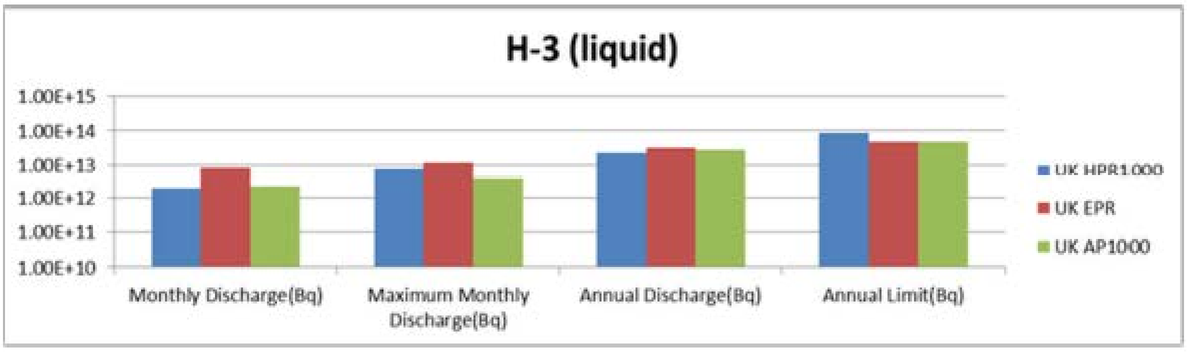
Gaseous - halogens - comparison of discharges and limits



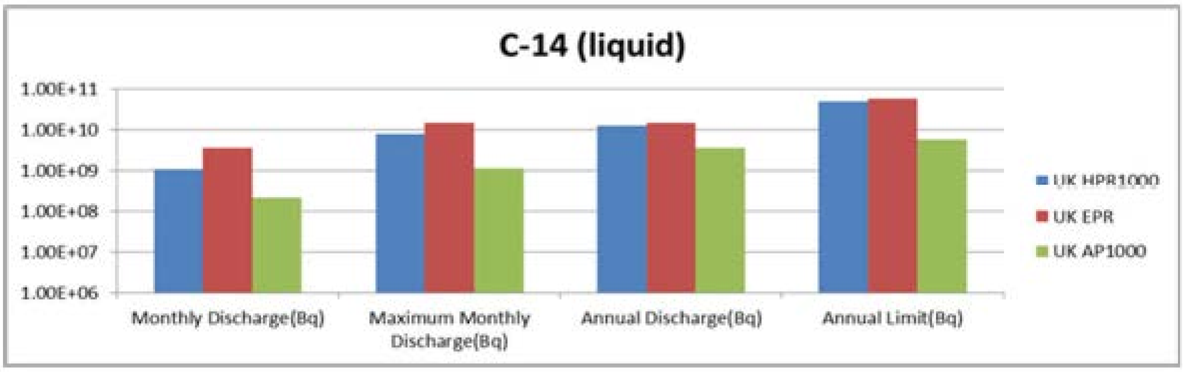
Gaseous - noble gases - comparison of discharges and limits



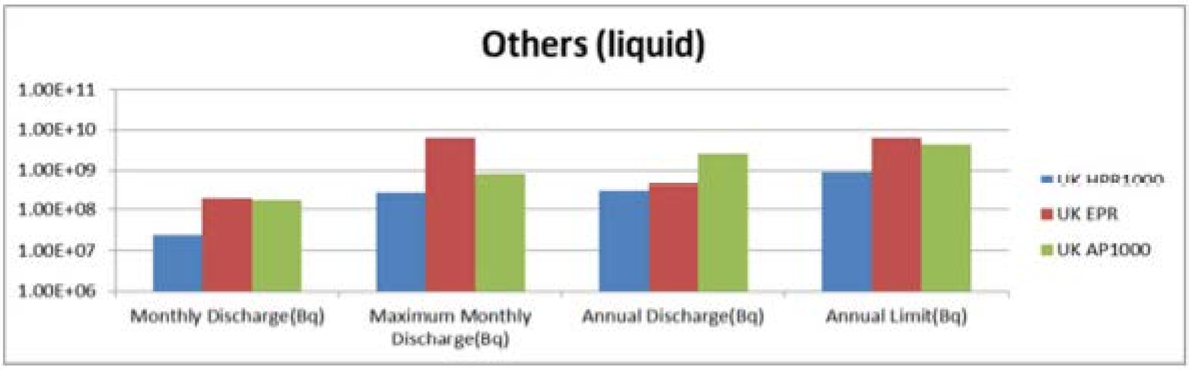
Gaseous - other radionuclides - comparison of discharges and limits



Liquid - Hydrogen-3 - comparison of discharges and limits



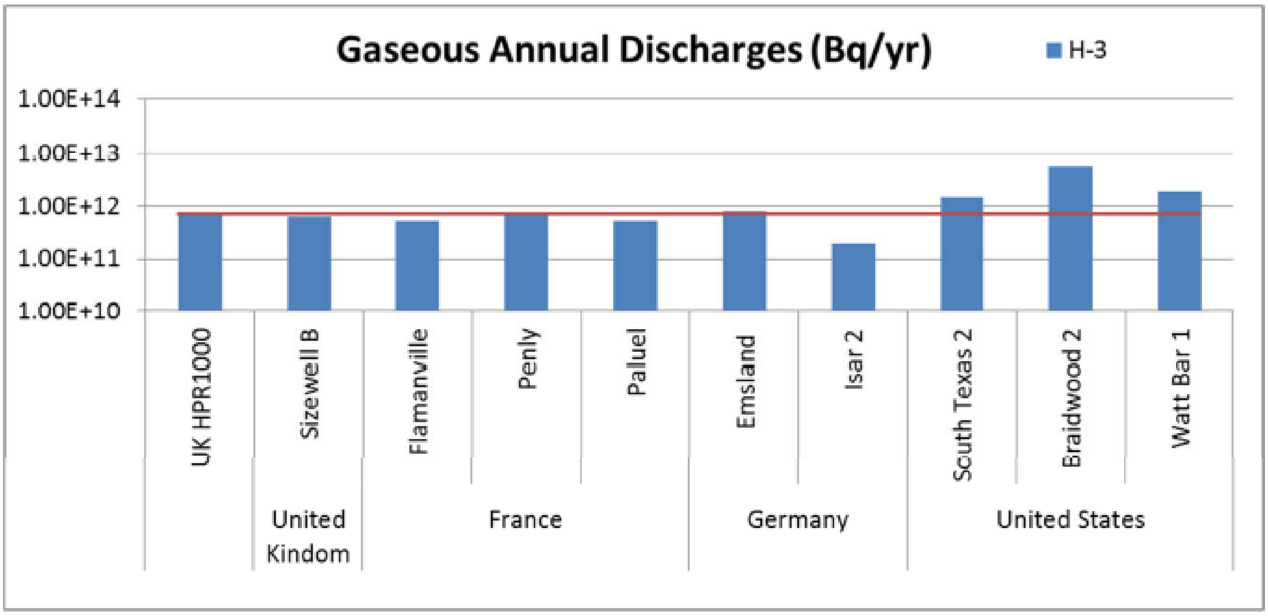
Liquid - Carbon-14 - comparison of discharges and limits



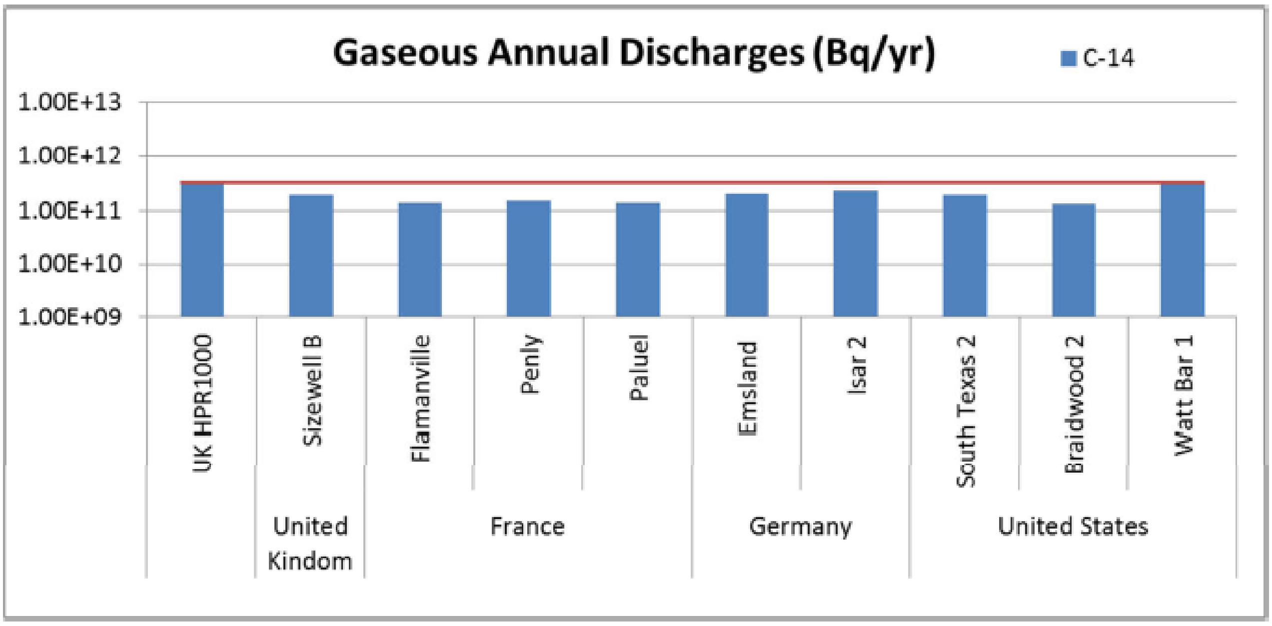
Liquid - other radionuclides - comparison of discharges and limits

Appendix 4 - Graphs showing comparison with international OPEX

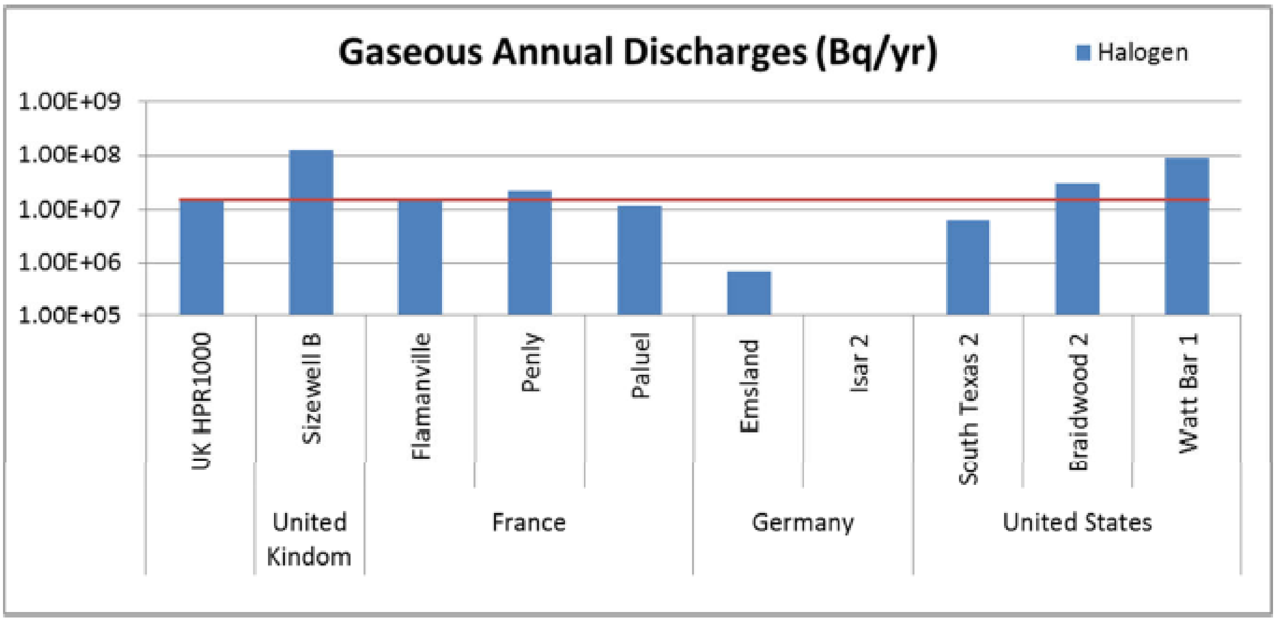
NOTE - all data used in the graphs are normalised to 1,000MWe to enable meaningful comparison (see section 3.4.5 above).



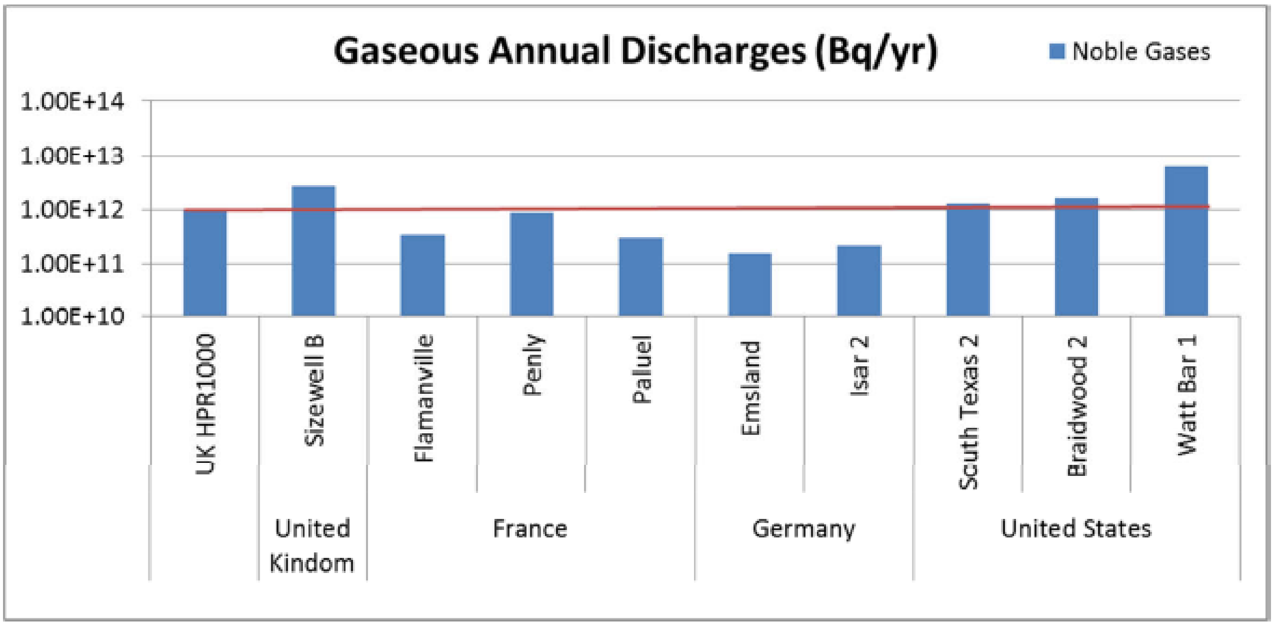
Gaseous - Hydrogen-3 - annual discharges



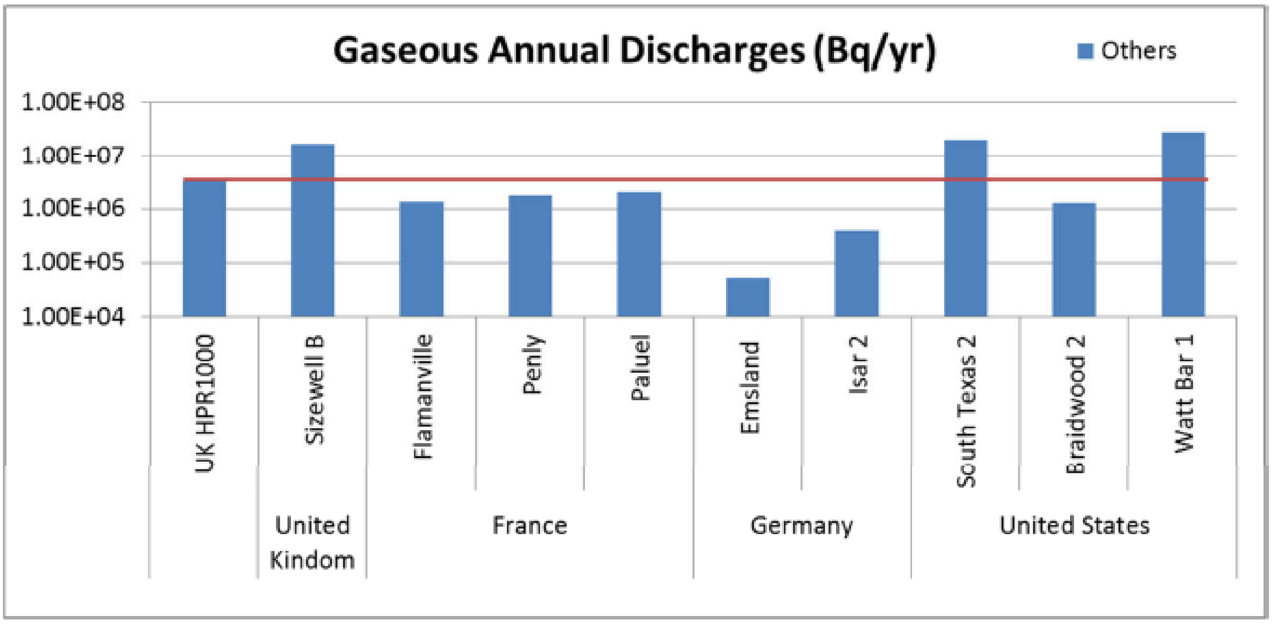
Gaseous - Carbon-14 - annual discharges



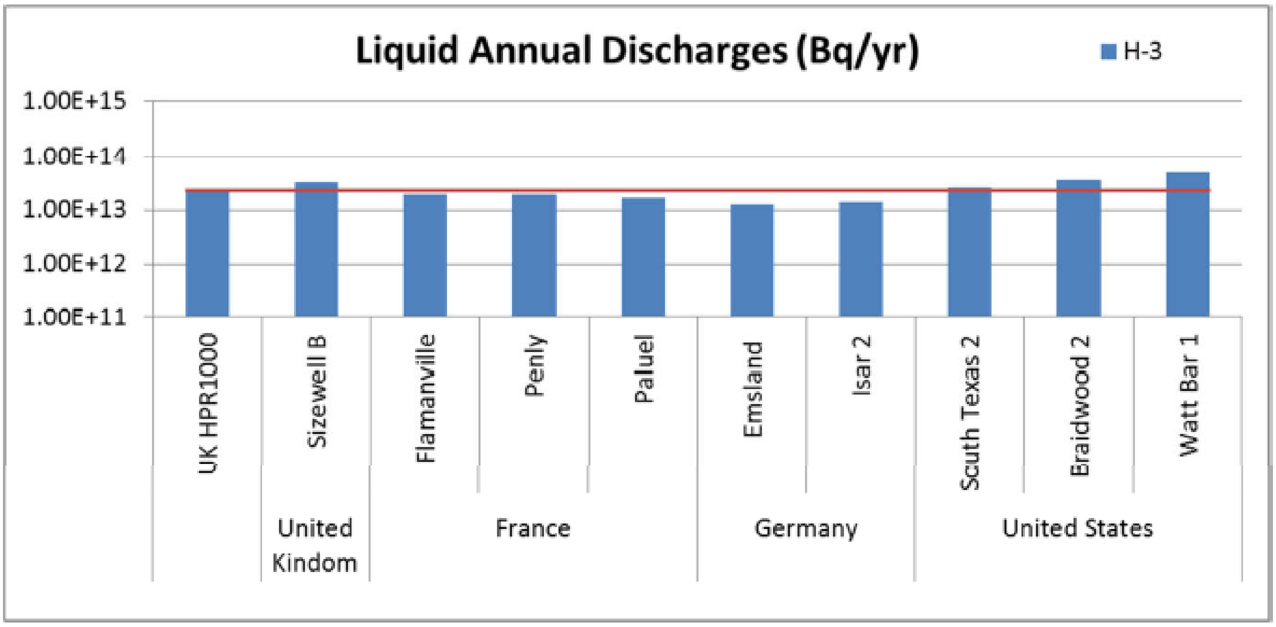
Gaseous - halogens - annual discharges



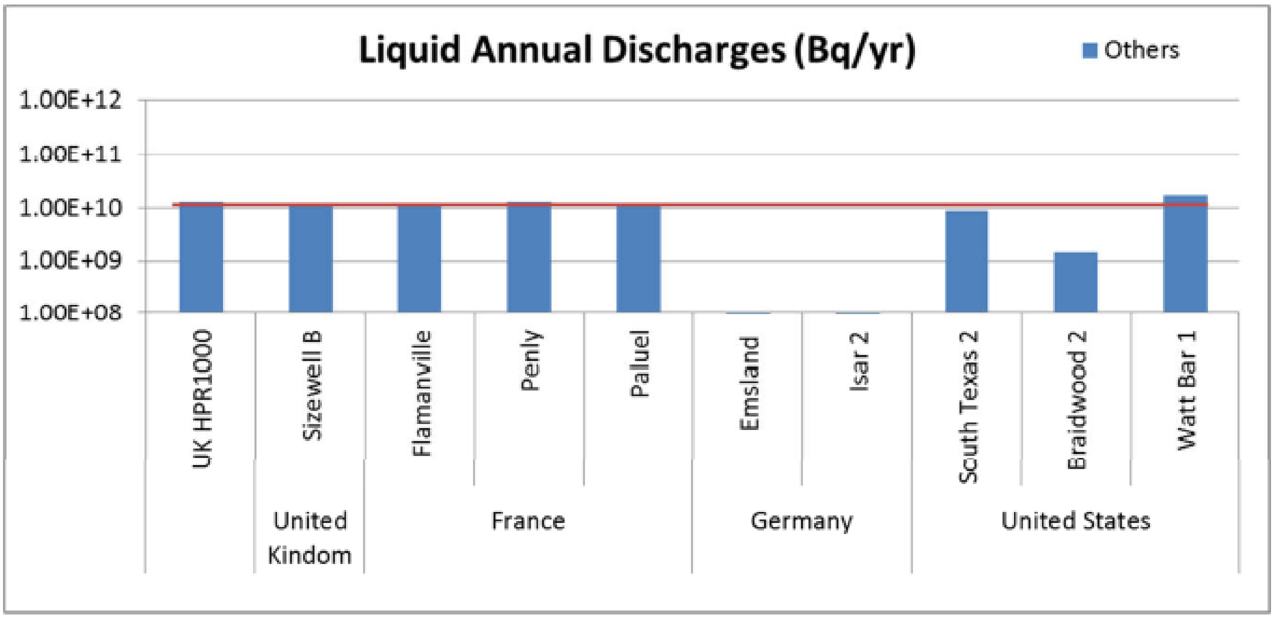
Gaseous - noble gases - annual discharges



Gaseous - other radionuclides - annual discharges



Liquid - Hydrogen-3 - annual discharges



Liquid - other radionuclides - annual discharges

Would you like to find out more about us or your environment?

Then call us on

03708 506 506 (Monday to Friday, 8am to 6pm)

email

enquiries@environment-agency.gov.uk

or visit our website

www.gov.uk/environment-agency

incident hotline

0800 807060 (24 hours)

floodline

0345 988 1188 (24 hours)

Find out about call charges (www.gov.uk/call-charges)

Environment first:

Are you viewing this onscreen? Please consider the environment and only print if absolutely necessary. If you are reading a paper copy, please don't forget to reuse and recycle.