Cyfoeth Naturiol Cymru
Natural Resources Wales

Environment Agency

Assessing new nuclear power station designs

Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor

Assessment report - AR10 Non-human dose

12 December 2016

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Executive summary

Protective status	This document contains no sensitive nuclear information or commercially confidential information.

Process and Information Document[1]	The following section of Table 1 in our process and information document (P&ID) (Environment Agency, 2013) is relevant to this assessment: Item 7: a prospective radiological assessment at the proposed limits for discharges and for any on-site incineration - include dose rate to non-human species

Radioactive Substances Regulation Environmental Principles[2]	The following principles (Environment Agency, 2010) are relevant to this assessment:
	RPDP3 – protection of non-human species: non-human species should be adequately protected from exposure to ionising radiation RPDP4 – prospective dose assessments from radioactive discharges into the environment: assessments of potential doses to people and to non-human species should be made prior to granting any new or revised permit for the discharge of radioactive wastes into the environment SEDP2 – migration of radioactive material in the environment: data should be provided to allow the assessment of rates and patterns of migration of radioactive materials in the air and the aquatic and terrestrial environments around sites

Report author	Dr Claire Cailes

This assessment considers the information Hitachi-GE provided for its UK Advanced Boiling Water Reactor (ABWR) design. This report is based on assessment of submissions provided up to and including 8 July 2016.

This report summarises the results of our assessment of the information Hitachi-GE provided and the assessment it carried out with respect to prospective doses to non-human species as a result of the disposal of gaseous and aqueous radioactive waste from the UK ABWR to the environment.

During our assessment, we raised 11 Regulatory Queries (RQs) that were related to dispersion of radionuclides in the environment, and one RQ that was related to non-human dose assessment.

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[1] Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs, Version 2, Environment Agency, March 2013. http://webarchive.nationalarchives.gov.uk/20151009003754/https://www.gov.uk/government/publications/assessment-of-candidate-nuclear-power-plant-designs

[2] Regulatory Guidance Series, No RSR 1: Radioactive Substances Regulation – Environmental Principles, Version 2, Environment Agency, April 2010. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/296388/geho0709bqsb-e-e.pdf

Hitachi-GE responded to all of these RQs and the generic design assessment (GDA) documentation has been updated.

Our assessment methodology involved undertaking a non-human dose assessment using the input data and parameters Hitachi-GE provided to ensure that its assessment could be reproduced. We also employed a Technical Support Contractor (TSC) to undertake an independent non-human dose assessment.

From our assessment, we conclude that the gaseous and aqueous discharges from the UK ABWR at the generic site are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative. Dose rates to non-human species resulting from Hitachi-GE's assessment and our independent assessment are well below the dose rate criterion of 10 μGy/h.

This assessment relates to predictions of impact based on a generic site. A detailed impact assessment will be required at site-specific permitting, based on the actual environmental characteristics of the proposed site, to demonstrate that doses to non-human species will be below relevant dose rate criteria.

We have not identified any Assessment Findings (AFs) or potential GDA Issues related to non-human dose assessment.

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1. Introduction

This assessment considers the impact of the UK ABWR on non-human species arising from discharges into the environment.

The assessment considers the information Hitachi-GE provided for its UK ABWR design. This report is based on assessment of submissions provided up to and including 8 July 2016.

We appointed a TSC (Quintessa) to make an independent assessment of the environmental activity concentrations of radionuclides from the UK ABWR at the generic site and to undertake an independent non-human dose assessment (Environment Agency, 2016a).

This assessment does not cover radioactive discharges arising from decommissioning at the end of the reactor life cycle. This is because operational discharges are expected to dominate the overall radiological discharges from any UK ABWR plant.

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 as currently written. It is recognised however, that the assessment should be kept under review to reflect changes in the statute, policy and guidance that may occur between now and plant commissioning and operation.

2. Assessment

This assessment considers the radiological impact of discharges from a single UK ABWR on non-human species.

2.1. Assessment methodology

The basis of our assessment was to:

- consider the submission Hitachi-GE made, which includes the generic environmental permit (GEP), relevant parts of the pre-construction safety report (PCSR) and supporting documents – see Table 1 in Section 2.3 below
- hold technical meetings with Hitachi-GE to clarify our understanding of the information presented and explain any concerns that we had with that information
- raise RQs to clarify our understanding of the information presented
- raise Regulatory Observations (ROs) and Regulatory Issues (RIs) where information Hitachi-GE provided was insufficient or unacceptable
- assess the radiological impact of discharges from a UK ABWR on non-human species to demonstrate that doses to non-human species from the UK ABWR at the generic site will not exceed the relevant dose rate criterion
- identify any potential GDA Issues and AFs to carry forward from GDA

Hitachi-GE provided its submission for GDA in December 2013. We carried out our initial assessment and concluded that we needed additional information and improved clarity on some aspects of the submission. We raised 9 RQs that were relevant to this report. Hitachi-GE submitted its updated submission in August 2014 and we carried out our detailed assessment. We raised 3 RQs that were relevant to this report.

In total, 12 RQs were relevant to this report over the course of our assessment (see Section 2.4 for more detail on each RQ). Hitachi-GE responded to the RQs and we accepted the responses.

Hitachi-GE reviewed and updated its submission in February 2016 and July 2016 to include all of the relevant information provided in response to the RQs.

2.2. Assessment objectives

Objectives of this assessment are to:

- Ensure that the non-human dose assessment undertaken by Hitachi-GE could be reproduced, so that we could understand how Hitachi-GE had undertaken its dose assessment and check for errors
- Undertake an independent non-human dose assessment
- Ensure that predicted dose rates to non-human species are below the relevant dose rate criterion

2.3. Hitachi-GE documentation

The generic environment permit (GEP) is divided into chapters and has supporting documents. We referred to the following Hitachi-GE documents to produce this report (Table 1):

Table 1. Hitachi-GE documentation reviewed for this assessment

Document reference	Title	Version number	Reference (latest revision)
GA91-9901-0020-00001; XE-GD-0095	Generic site description	Revisions A-E	Hitachi-GE, 2016a
GA91-9901-0025-00001; HE-GD-0004	Quantification of discharges and limits	Revisions A-F	Hitachi-GE, 2016b
GA91-9901-0026-00001; HE-GD-0005	Prospective dose modelling	Revisions A-F	Hitachi-GE, 2016c

No PCSR chapters were directly relevant to this report. Conclusions in this report are based on Revision F of GEP documents, except for the 'Generic site description' for which Revision E is the latest version.

2.4. Assessment results

This report summarises the results of our assessment of the information Hitachi-GE provided with respect to prospective doses to non-human species as a result of the proposed disposal of gaseous and aqueous radioactive waste from the UK ABWR to the environment.

In order to assess potential impacts, we required Hitachi-GE to carry out dose assessments as detailed in Item 7 of Table 1 of our P&ID (Environment Agency, 2013). In order to assess doses, we also required Hitachi-GE to describe a generic site on which the dose assessment was based and which represented sites earmarked for the building of new nuclear power stations in England and Wales. A separate assessment report has been prepared setting out our assessment of the generic site parameters Hitachi-GE provided (Environment Agency, 2016b). For consistency, the generic site description was also used in the assessment of potential impact on members of the public, for which we have prepared a separate assessment report (Environment Agency, 2016c).

In order to assess doses to non-human species, as well as the description of the environmental features of the generic site, we required Hitachi-GE to provide information about the discharges of

gaseous and aqueous radioactive waste from a UK ABWR, which we consider in our assessment reports (Environment Agency, 2016d, 2016e).

During the assessment of doses to non-human species, we requested clarity on several aspects of the submission by raising RQs. Eleven RQs were related to dispersion and build-up of radionuclides in the environment, which is a precursor to the public and non-human dose assessments; one RQ was related specifically to the non-human dose assessment undertaken by Hitachi-GE.

2.4.1. RQs related to dispersion and build-up of radionuclides in the environment

RQ-ABWR-0062 was raised on 13 March 2014 requesting an explanation as to why some radionuclides had been omitted from graphs showing build-up of radionuclides in the environment resulting from gaseous and aqueous discharges from a UK ABWR. Hitachi-GE responded to this RQ on 7 April 2014, stating it had omitted some radionuclides from the graphs in order to keep the graphs as clear as possible, but that it would add them in future revisions of the GEP. We accepted this response, and Hitachi-GE updated the GEP accordingly.

RQ-ABWR-0065 was raised on 13 March 2014 requesting a document that the GEP referred to as containing information on the basis for the proposed limits for gaseous and aqueous discharges. Hitachi-GE responded to this RQ on 7 April 2014, stating that the requested document was 'historic' and that the reference in GEP would be updated. The new reference was submitted to us and we accepted this response.

RQ-ABWR-0110 was raised on 14 April 2014 asking for the source of information provided in the GEP concerning the minimum stack height for Japanese ABWRs being 57 m. Hitachi-GE responded on 29 May 2014 detailing the source of this information and the stack heights of the 4 existing Japanese ABWRs. We accepted this response, although the GEP submission was not initially updated with this information. We raised RQ-ABWR-0876 on 10 May 2016 requesting that this information be included in the GEP submission. Hitachi-GE responded in full on 1 June 2016 stating that this information would be included in the GEP. We accepted this response and the GEP was updated accordingly.

RQ-ABWR-0111 was raised on 14 April 2014 asking for clarity on the footnotes under tables detailing environmental concentrations of radionuclides resulting from discharges from a UK ABWR. Hitachi-GE responded on 29 May 2014 explaining the footnotes; we accepted this response and the GEP was updated accordingly.

RQ-ABWR-0112, RQ-ABWR-0113, RQ-ABWR-0114 and RQ-ABWR-0115 were raised on 14 April 2014 and concerned Hitachi-GE's presentation and discussion of the build-up of radionuclides in the environment resulting from gaseous and aqueous discharges from a UK ABWR. Hitachi-GE responded to these RQs on 29 May 2014. We accepted the responses to these RQs and Hitachi-GE updated the GEP with improved graphs and discussion of the build-up of radionuclides in the environment.

RQ-ABWR-0116 was raised on 14 April 2014 requesting that a justification be provided for using the software package PC-CREAM 08 for the detailed environmental dispersion modelling for discharges from a UK ABWR. Hitachi-GE responded to the RQ on 29 May 2014 by proving a written justification explaining why PC-CREAM 08 was the most appropriate model to use for this assessment. Hitachi-GE stated that there are a number of models that are available for determining the radiological impact of routine discharges of radioactivity to the environment, including a Japanese model. However, the Japanese model only considered limited radionuclides. PC-CREAM 08 was selected as it consists of a package of models and data that can be used to perform prospective dose assessments, is tailored to the UK, and is a well-documented and tested software package. Hitachi-GE stated that PC-CREAM 08 and its underlying dispersion models are seen to be robust, fit-for-purpose and have been verified against environmental data. We accepted this response and the GEP was updated accordingly.

RQ-ABWR-0978 was raised on 14 July 2016 requesting clarification of the Kds used for the marine dispersion modelling undertaken using the PC-CREAM 08 software package. Our assessment suggested that Kds used were not the default values available in the PC-CREAM 08 package, and that other Kds had been assigned. However, this was not documented in the GEP submission. At the time of writing (5 August 2016), we had not received a response to this RQ.

2.4.2. RQ related specifically to non-human dose assessment

RQ-ABWR-0858 was raised on 27 April 2016 and it requested input data and parameters used to undertake the non-human dose assessment for aqueous discharges. This was requested because when we initially attempted to repeat the non-human dose assessment undertaken by Hitachi-GE, using the input data and parameters reported in the GEP, we could not obtain the same results for the marine assessment as Hitachi-GE had reported in the GEP. Hitachi-GE responded to this RQ on 1 June 2016 stating that the input data that it had used in its non-human dose assessment contained an error (for tritium concentration) meaning that the results reported by Hitachi-GE in the GEP were incorrect; this error was corrected and the updated GEP (Revision F) (Hitachi-GE, 2016c) contained the corrected results. We accepted this response, and repeated the non-human dose assessment again; our results were the same as that of Hitachi-GE.

We made an independent assessment of environmental activity concentrations of radionuclides from a UK ABWR at the generic site, and undertook an independent dose assessment for non-human species (Environment Agency, 2016a). This allowed us to efficiently and effectively understand and check the approach and methodology Hitachi-GE used. This supported our regulatory scrutiny of this reactor design, which is new to the UK and strengthened our confidence in the submission. The assessment was undertaken on our behalf by a TSC (Quintessa).

We carried out 2 evaluations of the assessment undertaken by Hitachi-GE:

- a validation exercise to satisfy ourselves that the results of the UK ABWR assessment could be reproduced
- an independent assessment to determine the dose rates using discharge data that Hitachi-GE provided and predicted activity concentrations modelled for us by the TSC

The results of our assessments are summarised in Table 3.

2.5. The assessment models

Dose assessment to non-human species involves dispersion modelling to predict the radionuclide activity concentrations in the environment resulting from gaseous and aqueous discharges, followed by an assessment of the impact of these radionuclides in the environment on non-human species.

PC-CREAM 08 is the accepted tool that is used for dispersion modelling to derive radionuclide activity concentrations in the environment from routine discharges (Smith and Simmonds, 2009). This tool can be used to predict radionuclides concentrations in soil, sediment, air and water from routine gaseous and aqueous discharges made over a set time period.

A number of systems have been developed to assess the risk to non-human species from ionising radiation. The accepted system for use in European ecosystems is the Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) integrated approach (Beresford et al., 2007).

The purpose of the ERICA integrated approach is to ensure that decisions on environmental matters give appropriate weight to the environmental exposure, effects and risks from ionising radiation with emphasis on ensuring the structure and function of ecosystems. The ERICA integrated approach is supported by the ERICA tool, a software programme with supporting database that can be used to assess environmental risks from ionising radiation (Brown et al., 2016).

The ERICA tool calculates the radiation dose rate that a reference organism is likely to receive from a defined activity concentration of a radionuclide. Reference organisms are used because given the variation between species, it is not generally possible to develop species-specific assessment systems. The reference organisms have been selected to be typical or representative of European ecosystems and include terrestrial, freshwater and marine environments.

The default screening value in the ERICA integrated approach is a dose rate of 10 µGy/h to be used for all ecosystems and all organisms. The criterion of 10 µGy/h is a screening value that is appropriate to use for a generic site when we do not know what impacts there may be from other sources of radioactive waste. For site-specific assessment, the Environment Agency, Natural England and the Countryside Council for Wales have agreed a dose rate criterion of 40 µGy/h, below which it is concluded that there are no adverse effects on the integrity of Natura 2000 sites. As GDA is based on a generic site, the appropriate dose rate criterion for non-human species is 10 µGy/h.

The ERICA integrated approach is organised into 3 separate tiers.

- Tier 1 is simple and conservative – it requires a minimal amount of input data, the user can select radionuclides from a default list and the results are for the combination of reference organisms that are exposed to the highest dose rates.
- Tier 2 is more specific and less conservative – the user can enter input data such as radionuclides that are not on the default list and edit transfer parameters. The results are calculated for each reference organism individually.
- Tier 3 is a probabilistic risk assessment in which uncertainties within the results may be determined using sensitivity analysis, and biological effects data needs to be considered - the situations requiring a tier 3 assessment are likely to be complex and unique.

The results produced from the ERICA tool includes a risk quotient, which provides a probability that the selected dose rate criteria may be exceeded.

The ERICA tool does not allow the assessor to consider the impact of radioactive noble gases. One tool that does allow this is the Argon-Krypton-Xenon (Ar-Kr-Xe) dose calculator (Vives i Batlle et al., 2015). This tool is based on the R&D 128 methodology (Copplestone et al., 2001), and consists of a basic tool with limited radionuclides which conducts a conservative assessment. This is the appropriate tool to use for assessment of dose to non-human species from noble gases.

2.6. Results of the assessment undertaken by Hitachi-GE

Hitachi-GE predicted the maximum discharges of radionuclides likely to occur from its UK ABWR design (assuming that discharges were made at proposed limits for 60 years), and used this data to assess the potential impact to non-human species. Proposed discharge limits for significant radionuclides are in Table 2. The non-human dose assessment took account of the build-up of these, and all other radionuclides expected to be discharged from a UK ABWR over 60 years. See the GEP Revision F, chapters on quantification of discharges and limits (Hitachi-GE, 2016b), and prospective dose modelling (Hitachi-GE, 2016c), for details of all radionuclides expected to be discharged from a UK ABWR and build-up of these radionuclides in the environment.

Table 2: Proposed discharge limits for the UK ABWR

	Radionuclide	Proposed annual limit for a UK ABWR (Bq)
Gaseous discharges	Argon-41(Ar-41)	5.2E+12
	Carbon-14 (C-14)	1.7E+12
	Tritium (H-3)	1.0E+13

	Radionuclide	Proposed annual limit for a UK ABWR (Bq)
	Noble gases (excluding argon-41)	2.2E+11
Aqueous discharges	Tritium (H-3)	7.6E+11

Hitachi-GE used PC-CREAM 08 to derive radionuclide activity concentrations. It then used the ERICA tool (version 1.2.0) and the Ar-Kr-Xe dose calculator to calculate dose rates to non-human species. Assessments of the impact of gaseous discharges were made to reference organisms inhabiting the terrestrial environment. Assessments of the impact of aqueous discharges were made to reference organisms inhabiting the marine environment. Hitachi-GE states that the UK ABWR does not make any discharges to the freshwater environment and hence did not consider impact on reference organisms inhabiting the freshwater environment. ERICA assessments were carried out at tier 2 as tier 1 did not include all of the radionuclides that Hitachi-GE predicts will be discharged from the UK ABWR.

Hitachi-GE has used the following parameters in its ERICA tier 2 assessment:

- The UK ABWR discharges gaseous and aqueous wastes to the environment at the level of the proposed limits for 60 years.
- Radionuclide activity concentrations resulting from gaseous discharges were made assuming the gaseous release was made from ground level (resulting in a very conservative assessment) and this was then scaled down to represent releases from a realistic stack height of 57 m.
- Default ERICA reference organisms were used.
- Default ERICA values for transfer parameters were used where available. Where default values were not available in the ERICA tool, values were manually assigned: for the marine assessment, the Kd and concentration ratios for iron (Fe) were taken from an International Atomic Energy Agency report (IAEA, 2004) as far as possible, remaining concentration ratios for iron were assigned based on the highest value for that reference organism across all of the radionuclides in the assessment; for the terrestrial assessment, concentration ratio values for carbon were used for that of iron, praseodymium (Pr), rubidium (Rb) and yttrium (Y).

The results of Hitachi-GE's terrestrial ERICA assessment identified that the reference organisms exposed to the highest dose rates were bird, large mammal, small burrowing mammal and reptile which received a dose rate of 6.1 µGy/h, but that the probability that the dose rate would exceed the dose rate criterion of 10 µGy/h was greater than 1%. This assessment conservatively assumes that the gaseous waste is discharged at ground level. Hitachi-GE refined the assessment by assuming that the gaseous waste was discharged from a realistic stack height of 57 m. The dose rate to the most exposed reference organisms was reduced to 0.27 µGy/h and the probability that the dose rate criterion of 10 µGy/h would be exceeded was less than 1%.

Hitachi-GE used the Ar-Kr-Xe dose calculator tool for its assessment of impact of noble gases on non-human biota. The results show that the most exposed reference organism was grasses and herbs, which received dose rates of 0.0064 µGy/h. When the results of the terrestrial ERICA assessment and the noble gas assessment are summed, the dose rates received by reference organism are well below the screening dose rate criterion of 10 µGy/h.

The results of Hitachi-GE's marine assessment identified that the reference organism exposed to the highest dose rate was mammal which received dose rate of 0.0003 µGy/h.

Hitachi-GE has shown that the dose rates to reference organisms in the terrestrial and marine environments are below the dose rate criterion of 10 µGy/h.

We consider the input parameters to be reasonable at this stage, because Hitachi-GE has assumed that discharges are made at the level of proposed limits, which is a conservative approach, and it has used default ERICA values (or more conservative parameters).

Hitachi-GE has not considered the impact that discharges of radionuclides might have on freshwater organisms as the UK ABWR design assumes no discharges are made to freshwater bodies. As part of any site-specific assessment, any future operator will need to consider if an assessment to freshwater organisms is needed.

2.7. Our assessment of the UK ABWR design

To evaluate the findings of Hitachi-GE we completed our own assessments (Environment Agency, 2016a) using the ERICA tool (version 1.2.1) and the Ar-Kr-Xe dose calculator tool. We used the same input data and parameters that Hitachi-GE used and the results are summarised in Table 3. For the terrestrial assessment, we obtained the same results as Hitachi-GE. For the marine assessment, we initially obtained slightly higher dose rates for all reference organisms than that reported in GEP Revision E. We raised RQ-ABWR-0858 requesting details of input data and parameters used for the assessment of the marine environment. Hitachi-GE responded stating that it had made an error in its input of data to the ERICA tool (for tritium concentrations). This error was corrected and updated results were presented in GEP Revision F (Hitachi-GE, 2016c). Results presented in GEP Revision F were also updated for changes to the source terms for gaseous and aqueous discharges (Hitachi-GE, 2016b). When we repeated the assessment undertaken by Hitachi-GE, our results were the same as those reported by Hitachi-GE in GEP Revision F.

2.8. Environment Agency ERICA assessment

We used our independently calculated activity concentrations, which were calculated using PC-CREAM 08, in the ERICA assessment and the results are shown in Table 3. The dose rate to the most exposed terrestrial reference organisms (bird, reptile, large mammal and small burrowing mammal) is 0.23 µGy/h, and assumes that discharges are made from a realistic stack height. The dose rate to the most exposed marine reference organism (mammal) is 0.00039 µGy/h. The highest dose rates to reference organisms are well below the dose rate criterion of 10 µGy/h. The results show that the probability that the dose rates to any reference organism will exceed 10 µGy/h are less than 1%.

2.9. Environment Agency noble gas assessment

To assess risks to terrestrial organisms from noble gases, we used the Ar-Kr-Xe dose calculator tool and our own independently modelled activity concentrations (Environment Agency, 2016a). The dose rate to the most exposed reference organism (lichens and bryophytes) was 0.00024 µGy/h. This is well below the dose rate screening criterion of 10 µGy/h.

Table 3: Results of Hitachi-GE's assessment and our assessment of dose rates to non-human species.

Assessment type	Data source	Highest dose rate to any reference organism (µGy/h)	
		Hitachi-GE results	Our results
Terrestrial assessment from gaseous discharges			
ERICA tier 2	Hitachi-GE (assuming ground level release)	6.09	Same as Hitachi-GE results
	Hitachi-GE (assuming release from stack)	0.27	Same as Hitachi-GE results

Assessment type	Data source	Highest dose rate to any reference organism (µGy/h)	
		Hitachi-GE results	Our results
	Independent (assuming release from stack)	Not applicable	0.23
Ar-Kr-Xe dose calculator	Hitachi-GE	0.0064	Same as Hitachi-GE results
	Independent	Not applicable	0.00024
Total	Hitachi-GE (assuming ground level release)	6.09	Same as Hitachi-GE results
	Independent (assuming release from stack)	Not applicable	0.23
Marine assessment from aqueous discharges			
ERICA tier 2	Hitachi-GE	0.0003	Same as Hitachi-GE results
	Independent	Not applicable	0.00039

3. Variability

There is some variability between the results of the assessments undertaken by Hitachi-GE and that undertaken by our independent TSC. Our independent terrestrial assessment of gaseous discharges from a UK ABWR showed that non-human biota would be exposed to lower dose rates than those calculated by Hitachi-GE. The variation in terrestrial dose rates from gaseous discharges is due to differences in assumptions made about the location of non-human receptors. Hitachi-GE calculated terrestrial dose rates to non-human biota at 100 m from the stack whereas our TSC calculated dose rates at a greater distance of 300 m from the stack.

Our marine assessment of aqueous discharges from a UK ABWR showed that non-human biota would be exposed to slightly higher dose rates than those calculated by Hitachi-GE. This variation is due to differences in the parameters used in the marine dispersion modelling. Our TSC used marine dispersion characteristics representative of the Oldbury site, a site earmarked for a new nuclear power station, which has one of the lowest rates of dispersion of any nuclear site in England and Wales. This low rate of marine dispersion leads to higher concentrations of radionuclides in the marine environment resulting in higher dose rates to non-human biota. In addition, some variation in the calculated dose rates may be due to our independent assessment being completed using the latest version of the ERICA tool (version 1.2.1); Hitachi-GE undertook its assessment on an earlier version of the ERICA tool.

4. Compliance with Environment Agency requirements

Table 4. Compliance with Environment Agency requirements

Environment Agency requirement	Comments
P&ID Table 1 Requirement 7: a prospective radiological assessment at the proposed limits for discharges and for any on-site incineration. Include dose rate to non-human species.	Compliant - an assessment of impact on non-human species was made by Hitachi-GE based on discharges at proposed limits.
RPDP3 – Protection of non-human species: non-human species should be adequately protected from exposure to ionising radiation.	Compliant - dose rates to non-human species from gaseous and aqueous discharges from the UK ABWR are well below the dose rate criterion of 10 µGy/h.
RPDP4 – Prospective dose assessments from radioactive discharges into the environment: assessments of potential doses to people and to non-human species should be made prior to granting any new or revised permit for the discharge of radioactive wastes into the environment.	Compliant - a prior assessment has been made based on the generic site. We will require that prospective dose assessments are carried out by any future operators at the site-specific stage as part of the permitting process and using information specific to the site in question.
SEDP2 – Migration of radioactive material in the environment: data should be provided to allow the assessment of rates and patterns of migration of radioactive materials in the air and the aquatic and terrestrial environments around sites.	Compliant - information on the potential migration of radioactive material in the environment was provided by Hitachi-GE.

5. Public comments

The Hitachi-GE led public comments process did not receive any public comments relating to the assessment of the radiological impact of discharges from a UK ABWR on non-human species.

6. Conclusion

From our assessment, we conclude that the gaseous and aqueous discharges from a UK ABWR at the generic site are unlikely to pose a risk to non-human species.

We consider the assessment undertaken by Hitachi-GE to be conservative and reasonable and we consider that Hitachi-GE has used an appropriate approach to assess the radiological impacts of the UK ABWR on non-human species.

From our assessment of Hitachi-GE's submission, we conclude that for each reference organism, the probability of the dose rates exceeding the dose rate criterion of 10 µGy/h is less than 1%. The highest dose rate to any reference organism from gaseous discharges (assuming realistic stack

height) is 0.27 µGy/h. The highest dose rate to any reference organism from aqueous discharges is 0.0003 µGy/h. These dose rates are well below the dose rate criterion of 10 µGy/h.

From our independent non-human dose assessment, we conclude that for each reference organism, the probability that the dose rate will exceed the screening dose rate criterion of 10 µGy/h is less than 1%. The highest dose rate to any reference organism from gaseous discharges is 0.23 µGy/h. The highest dose rate to any reference organism from aqueous discharges is 0.00039 µGy/h. These dose rate are well below the dose rate criterion of 10 µGy/h.

This assessment relates to predictions of impact based on a generic site. A detailed impact assessment will be required at site-specific permitting, based on the actual environmental characteristics of the proposed site, to demonstrate that doses to non-human species will be below relevant dose rate criteria.

We have not identified any AFs or potential GDA Issues related to non-human dose assessment.

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List of abbreviations

Abbreviation	Details
AF	Assessment Finding
ALARP	As low as reasonably practicable
BAT	Best available techniques
GDA	Generic design assessment
GEP	Generic environmental permit
PCSR	Pre-construction safety report
RI	Regulatory Issue
RO	Regulatory Observation
RQ	Regulatory Query
TSC	Technical support contractor
UK ABWR	UK Advanced Boiling Water Reactor

Glossary

Word / Phrase	Meaning
Activity concentration	The amount of radioactivity per unit mass or volume of a substance expressed in units of Becquerels per kilogram (Bq/kg) or Becquerels per litre (Bq/l).
Discharge	Disposal of gaseous or aqueous radioactive waste to the environment.
Dose	The amount of energy deposited per unit mass of tissue from an exposure to ionising radiation expressed in units of gray (Gy).
Dose assessment	The calculation of the impact of a source of radioactivity on a receptor in terms of dose taking into account exposure pathways.
Dose rate	The dose received per unit time expressed in units of microGray per hour (µGy/h).
Kd	The solid/liquid partition coefficient – in this report this is the ratio between the concentration of radionuclides in sediment and water.
Radionuclide	A radioactive isotope that emits ionising radiation
Reference organisms	Organisms that are typical or representative of those organisms present in an environment.
Transfer parameters	Values used to calculate where an element concentrates in the environment. In this report they are Kd (ratio between concentration in sediment and water) and concentration ratio (ratio between concentration in the environmental medium and a living organism).

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