Cyfoeth Naturiol Cymru
Natural Resources Wales

Environment Agency

Assessing new nuclear power station designs

Generic design assessment of Hitachi-GE Nuclear Energy Limited's UK Advanced Boiling Water Reactor

Decision document

December 2017

The Environment Agency protects and improves the environment.

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Natural Resources Wales is the largest Welsh government sponsored body. We were formed in April 2013, largely taking over the functions of the Countryside Council for Wales, Forestry Commission Wales and the Environment Agency in Wales, as well as certain Welsh government functions.

Natural Resources Wales' purpose is to pursue sustainable management of natural resources in all of our work.

Natural Resources Wales brings together the skills and expertise needed to ensure that we can operate effectively across our wide range of roles from adviser, facilitator, regulator and designator, to incident responder, partner and operator.

Published by:

Environment Agency
Horizon House, Deanery Road,
Bristol BS1 5AH
Email: enquiries@environment-agency.gov.uk

and

Natural Resources Wales
Cambria House, 29 Newport Road,
Cardiff CF24 0TP

Email: enquiries@naturalresourceswales.gov.uk

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or

National Customer Contact Centre:
Environment Agency : 03708 506506

Email: enquiries@environment-agency.gov.uk.

or

Natural Resources Wales: 0300 065 3000

Email: enquiries@naturalresourceswales.gov.uk

Foreword

We, the Environment Agency and Natural Resources Wales, are the independent environmental regulators for nuclear sites in England and Wales respectively. We work to create better places for people and wildlife, and support sustainable development. This includes our environmental regulation of nuclear power stations to ensure that they meet the high standards that we expect.

We are pleased to introduce this document that sets out our conclusions and decisions on the acceptability of Hitachi-GE’s UK Advanced Boiling Water Reactor (UK ABWR) following our generic design assessment (GDA) of this reactor design.

We have decided to issue a statement of design acceptability (SoDA) for Hitachi-GE's UK ABWR. This document explains the reasons for our decision and provides responses to the matters that were raised when we consulted on the preliminary findings of our assessment. We are grateful for all who took the time to attend our consultation events and to provide us with responses. In making our decision, we have carefully considered all of the comments that we have received.

GDA is a joint process of the Office for Nuclear Regulation (ONR), the UK regulator for nuclear safety and security, and the Environment Agency and Natural Resources Wales, the environmental regulators for England and Wales respectively. We are working together to ensure that any new nuclear power stations built in England and Wales meet high standards of safety, security, environmental protection and waste management.

The objectives of our GDA process and assessments are to:

- have an early influence on potential reactor designs that might be built in England and Wales so that we can be confident that they will meet high standards of safety, security, environmental protection and waste management
- provide potential developers and investors in any new nuclear stations with our views about the designs, so reducing potential programme risks arising from regulatory scrutiny
- conduct, subject to normal national and commercial security constraints, an open and transparent process of assessment
- foster and provide effective and efficient working by the nuclear regulators not just in GDA, but in our future work together permitting, licensing and regulating potential new nuclear power stations in England and Wales
- contribute to government's growth initiatives, by growing potential investors' understanding and confidence in our expectations and regulatory approach for new nuclear build

The GDA programme is meeting these objectives.

The publication of this document sees the completion of a programme of work that the regulators and Hitachi-GE began in early 2014. We thank our and ONR's staff for their hard work, enthusiasm and dedication over this period of assessment. We similarly thank Hitachi-GE and its staff for how they have responded to our many questions and challenges and for coming to understand our regulatory expectations and culture in the UK.

It is all of this effort that has enabled us to come to the view that the UK ABWR is suitable for construction in the UK. We look forward to dealing with proposals for construction of the UK ABWR at Wylfa and Oldbury.

Toby Willison

Tim Jones

Executive Director Operations

Environment Agency

Executive Director Operations North and Mid Wales

Natural Resources Wales

Executive summary

About generic design assessment (GDA)

1. The UK government's energy policy (GB Parliament, 2008a) identifies that nuclear power could play a vital role, alongside gas and renewable energy sources, such as wind and solar power, in making sure that the UK has enough low-carbon electricity in the future.

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

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

4. Because Natural Resources Wales and the Environment Agency have made their decision together, the GDA outcome applies in both England and Wales. References to 'we' and 'our' throughout this document refer to both the Environment Agency and Natural Resources Wales, unless specified otherwise.

5. We carry out the GDA process in 2 stages: initial assessment and detailed assessment.

6. There are 3 possible outcomes for a GDA.

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

   Where we issue a SoDA or iSoDA we will also likely identify 'Assessment Findings' for resolution by developers/operators at a later stage, for example, during procurement or commissioning.

– A **GDA Issue** is an unresolved issue that is significant, but resolvable, and which requires resolution before construction of the reactor starts. The company must publish a 'resolution plan' setting out how it will address the issue. All GDA Issues must be resolved to the satisfaction of the regulators before GDA can be completed.

– An **Assessment Finding** is an unresolved issue that is not considered critical to the decision to start construction - it will need to be addressed during the design, procurement, construction or commissioning phase of the new build project.

About GDA for Hitachi-GE's UK ABWR design

7. Hitachi-GE submitted its UK ABWR design for GDA in December 2013. It published the submission on its website and invited people to comment on it. Hitachi-GE has revised the submission during GDA; the current version on the website is up to date and is the basis of our detailed assessment (Appendix 3).

8. We completed our initial assessment of the UK ABWR and published our Initial Assessment Report in August 2014.

9. We carried out our detailed assessment of the UK ABWR and consulted on our preliminary conclusions, as set out in the consultation document we published (Environment Agency and Natural Resources Wales, 2016a), from 12 December 2016 to 3 March 2017.

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

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

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

Our decision on the UK ABWR design

13. Following our detailed assessment, our conclusion is that we can issue a SoDA for the UK ABWR and this is included as Appendix 1.

14. In reaching our decision, we have identified 17 Assessment Findings. These Assessment Findings are summarised below, but should be read with the supporting information presented in our assessment reports to provide context. We expect future operators to address the findings during the detailed design, procurement, construction or commissioning phase of any new build project.

- **Assessment Finding 1**: A future operator shall provide details of how the proximity principle has been applied in its demonstration of best available techniques for solid and incinerable liquid wastes before it starts active commissioning of the UK ABWR
- **Assessment Finding 2**: If appropriate, a future operator shall produce an assessment of best available techniques that covers all of its sites, noting economies of scale and other efficiencies in disposal of solid and incinerable liquid wastes across all of its sites before it starts active commissioning of the UK ABWR
- **Assessment Finding 3**: A future operator shall demonstrate that the UK ABWR will be operated in a manner that represents best available techniques, addressing in particular:
    - fuel selection
    - fuel and core management
    - avoidance of control rod failure in power suppression situations
    - consideration of all normal operational modes and stages of the reactor's lifecycle
    - control of water chemistry
    - selection of demineraliser resins for liquid waste management systems
- **Assessment Finding 4**: A future operator shall review the practicability of techniques for abatement of carbon-14 prior to operation.

- **Assessment Finding 5**: A future operator shall assess the partitioning of carbon-14 between gaseous, aqueous and solid waste streams, during initial operations.
- **Assessment Finding 6**: A future operator shall address the 15 forward actions as identified by Hitachi-GE in the 'Demonstration of best available techniques' submission - GA91-9901-0023-00001 Rev. G. August 2017 (Hitachi-GE, 2017a).
- **Assessment Finding 7**: A future operator shall provide an evidence based definition of the decontamination factors likely to be achieved for aqueous effluent treatment prior to operation and then compare these with the actual decontamination factors achieved during operation. Differences in expected and actual decontamination factors should be explained.
- **Assessment Finding 8**: A future operator shall assess the chemical speciation of radioactivity in aqueous discharges. It shall consider the implications of this for the receiving environment so that discharges are shown to represent best available techniques.
- **Assessment Finding 9**: A future operator shall, before procurement, provide detailed designs for solid radioactive waste management, storage and conditioning facilities that were covered at a conceptual level during generic design assessment, and demonstrate how these represent best available techniques.
- **Assessment Finding 10**: A future operator shall demonstrate optimised management and disposal of solid radioactive wastes from the UK ABWR, addressing in particular:
    - conditioning of higher activity waste arisings to ensure disposability
    - selection of disposal routes for wastes at the low activity waste/high activity waste boundary
    - management of spent nuclear fuel and any associated secondary wastes to ensure disposability
    - selection of disposal routes for low activity waste
- **Assessment Finding 11**: A future operator shall address the 12 forward actions identified in the 'Approach to sampling and monitoring' submission - GA91-9901-0029-00001 Revision H, August 2017 (Hitachi-GE, 2017b).
- **Assessment Finding 12**: A future operator shall undertake tests to determine the particle concentration profile and whether multi-nozzle probes are required for the main stack sampling.
- **Assessment Finding 13**: A future operator shall demonstrate, prior to reactor commissioning, that the final configuration of the sampling lines and the layout and positioning of the monitoring room are optimised.
- **Assessment Finding 14**: A future operator shall demonstrate that, prior to procurement, the specific sampling and monitoring equipment for the determination of the discharges represents best available techniques and enables the EU recommended levels of detection to be met.
- **Assessment Finding 15**: A future operator shall demonstrate that the systems and equipment used for monitoring and sentencing solid waste represent best available techniques.
- **Assessment Finding 16**: A future operator shall appropriately characterise all aqueous waste streams in its water discharge activity permit application. This shall include identification of all significant contaminants (including biocides, detergents and metals), the concentrations and volumes being discharged to the environment.
- **Assessment Finding 17**: A future operator shall specify the minimum performance parameters of the combustion plant in its application for an installations permit.

15. ONR's GDA Step 4 assessment has also concluded and it has reached a decision to issue a design acceptance confirmation.

What happens next?

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

Contents

1. About this decision document

The purpose of this document is to explain our decision, following assessment and consultation, regarding the acceptability of a new nuclear power plant design, the UK Advanced Boiling Water Reactor (UK ABWR) by Hitachi-GE Nuclear Energy Limited (the 'requesting party').

The Office for Nuclear Regulation (ONR) has also assessed the UK ABWR from a safety and security viewpoint. Although we work closely with ONR, this decision is only about the Environment Agency and Natural Resources Wales's assessment and not ONR's. Where consultation responses raised safety or security issues, we have passed them on to ONR.

Our assessment and our decision is about the environmental aspects of the proposed design. It is not about the need for nuclear power or the siting of nuclear power stations.

About this document

17. This document provides:

- an introduction to our role in nuclear regulation and the basis for generic design assessment (GDA) (Chapter 2)
- an outline of the UK ABWR design (Chapter 3)
- a guide to our detailed assessment (Chapter 4)
- our GDA conclusions, following our detailed assessment (Chapters 5 to 18)
- our overall conclusion (Chapter 19)
- appendices supporting the decision document (Appendices 1 to 9)

18. The detailed assessments provided in Chapters 5 – 18 are essentially the same as those provided in the consultation document, but updated, where appropriate, to reflect:

- our assessment of any further information, if provided by Hitachi-GE, since the consultation date
- the further work that we said, in the consultation document, that we intended to do
- matters arising from ONR’s GDA Step 4 work that are relevant to our assessment
- any change in our approach or conclusions arising from our consideration of relevant consultation responses
- any change in our approach or conclusions arising from our consideration of comments received on Hitachi-GE's website, and Hitachi-GE's responses
- reference to our updated assessment reports, these contain further detail, including how our assessment has taken account of consultation responses and comments where relevant to each topic

The questions we asked as part of our consultation are listed in Appendix 5. All the consultation responses we received are listed in Appendix 7, together with our replies. Where the response and our reply relate to a specific technical area of our assessment we have identified the relevant assessment report in Appendix 7.2. A number of responses did not directly concern GDA and these are summarised in Appendix 7.3. Where we referred responses to other organisations these are listed in Appendix 7.4.

2. Introduction

19. This chapter describes the Environment Agency and Natural Resources Wales' role in nuclear regulation and the development of new nuclear power stations, and how we carry out generic design assessment.

Government policy on nuclear new build - the origins of GDA

The government has outlined its commitment to a significant expansion in new nuclear in the UK, stating that nuclear power, alongside gas and renewable energy sources, will ensure the UK has enough low carbon electricity in the future. It has taken a number of actions to facilitate the development of new nuclear, including asking the nuclear regulators (Environment Agency, Natural Resources Wales and ONR) to consider 'pre-authorisation assessments' of new nuclear power stations. In response, the regulators developed GDA, which allows us to assess the safety, security and environmental impacts of new reactor designs at a generic level, before receiving an application to build a particular nuclear power station design at a specific location.

Our role in nuclear regulation

20. The Environment Agency and Natural Resources Wales regulate the environmental impacts of nuclear sites in England and Wales respectively, such as nuclear power stations, nuclear fuel production plant, and plant for reprocessing spent nuclear fuel. We do this through a range of environmental permits. These permits may be needed for one or more of the site preparation, construction, operation and decommissioning phases of the plant's life cycle.

21. We work together so that the GDA outcome applies in both England and Wales. References to 'we', 'our', or similar terms throughout this document refer to both the Environment Agency and Natural Resources Wales, unless specified otherwise. In this GDA, where reference is made to Environment Agency documents the reader is to assume that Natural Resources Wales accepts and has adopted such documents as its own.

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

Radioactive substances regulation for nuclear sites

Radioactive and nuclear substances and waste

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

24. We regularly review permits, and vary them if necessary, to ensure that the conditions and limits are still effective and appropriate.

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

Our regulatory role in the development of new nuclear power stations

26. As for existing nuclear sites, any new nuclear power station will require environmental permits from us to cover various aspects of site preparation, construction, operation and eventually

decommissioning. Based on learning from new build overseas and in the light of government and industry expectation that power stations of almost the same design might be built on a number of sites and potentially be run by different operating companies, we have split our process for assessing and permitting the operational stage of new nuclear power stations into 2 phases.

First phase: Generic design assessment (GDA)

27. In the first phase, GDA, we carry out assessments of candidate designs and, at the end, provide a statement about the acceptability of the design. There may be GDA Issues and Assessment Findings associated with the statement. For the UK ABWR, we have now completed this phase with no remaining GDA Issues and 17 Assessment Findings. This decision document is about our assessment of the UK ABWR design and our conclusions.

– A **GDA Issue** is an unresolved issue that is significant, but resolvable, and which requires resolution before construction of the reactor starts. The company must publish a 'resolution plan' setting out how it will address the issue. All GDA Issues must be resolved to the satisfaction of the regulators before GDA can be completed.

– An **Assessment Finding** is an unresolved issue that is not considered critical to the decision to start construction - it will need to be addressed during the design, procurement, construction or commissioning phase of the new build project. Issue of a final SoDA is, therefore, not dependent on clearance of Assessment Findings. We may address Assessment Findings in site-specific permits, by means of pre-operational conditions or improvement and information requirements.

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

Second phase: Site-specific

29. In the second phase, we receive applications for environmental permits for specific sites. In determining these applications, we take full account of the work we have done during GDA, so that our efforts are focused on operator and site-specific matters, including how the operator has addressed any outstanding GDA Issues (where there is overlap between a site-specific application and completion of GDA) or Assessment Findings. We also carry out further public consultation before deciding whether or not to issue operational permits for a specific site.

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

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

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

These include:

- **Strategic siting assessment** - this work identified those sites that are strategically suitable for the deployment of new nuclear power stations by the end of 2025. The selected sites are listed in the 'National policy statement for nuclear power generation: EN-6' ('NPS EN-6') (GB Parliament, 2011a). This provides the framework for decisions on planning consent (Development Consent Orders). Such decisions are taken by the Secretary of State for the Department for Business, Energy and Industrial Strategy (BEIS) on the basis of recommendations made by the Planning Inspectorate.

- **Justification -** before any new type of nuclear power station can be built in the UK, it must be 'justified', that is, it must be shown that the net benefits outweigh any health detriment. The government made a decision that the UK ABWR is justified in December 2015 (DECC, 2014b).
- **Funded decommissioning programme -** 'The Energy Act 2008' (GB Parliament, 2008b) requires any operator of a new nuclear power station to have a funded decommissioning programme, approved by the Secretary of State, in place before construction begins, and to comply with this programme. The government published funded decommissioning programme guidance in December 2011 (GB Parliament, 2011b).

About generic design assessment (GDA)

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

GDA process

31. Our guidance (Environment Agency, 2016b) sets out in detail the information that we require and the process that we follow during GDA. This has been updated since the 2013 version we referred to in our consultation document, but there have been no significant changes to the information we require or to our process. Our process generally has 6 main elements, with a seventh to be used if we issue an interim statement of design acceptability (iSoDA).

1. Initiation - we make agreements with the requesting party under Section 37 of the Environment Act 1995 (GB Parliament, 1995) and the Natural Resources Body for Wales (Establishment) Order 2012 (as amended) (National Assembly of Wales, 2012) and provide advice on the development of a submission.

2. Initial assessment - we receive the submission and examine it, at an outline level, to find out if:

- we need further information
- there are any matters that are obviously unacceptable, including from our assessment of the radiation doses that might be received by the public and the environment
- any significant design modifications are likely to be needed.

3. Detailed assessment - we examine the submission in detail to come to a preliminary view on whether:

- we might issue a statement of design acceptability (SoDA)
- we might issue an interim statement of design acceptability (iSoDA) with associated GDA Issues
- the design is not acceptable and we will not issue a SoDA/iSoDA.

4. Consultation - we consult widely on our preliminary view following detailed assessment. We provide a consultation document explaining the reasons for our preliminary view.

5. Post consultation review - we carefully consider all relevant responses to the consultation and complete our assessments.

6. Decision and statement - we decide whether or not to issue a SoDA or iSoDA. We publish a decision document explaining the reasons for our decision.

7. Resolving GDA Issues - we assess the further information provided to clear the GDA Issues and, if satisfied, issue a full SoDA.

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

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

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

Scope of GDA

34. The regulators require a reasonable level of detail to be provided by requesting parties to be able to complete a GDA, but recognise that full engineering details of the design may not be available at the GDA stage, as it is normal to finalise some of these as part of the procurement and construction programme.

35. The scope of what is included within GDA depends on the information supplied by the requesting party (GDA is a voluntary process). However, the information provided for GDA needs to be sufficient in scope and detail to enable a meaningful assessment of the safety, security and environmental aspects of the design. We will not be able to proceed with an assessment if the information we require is not available or omitted.

36. The scope of GDA is defined by the totality of the information provided in the submission to the regulators (as recorded in a 'master document submission list'), together with the 'design reference'. The design reference is a list of all the documents that together describe the design of the reactor and associated plant. We require this to be 'frozen' at a specific date known as the 'design reference point', but it can be updated during the assessment.

GDA outcomes

37. There can be 3 different outcomes for a GDA:

- If we are fully content with the environmental aspects of the design, we provide the requesting party with a SoDA. However, there may still be some Assessment Findings that a future operator will need to resolve at a later stage, such as during procurement or commissioning or early operation. We will not issue a SoDA if ONR cannot issue a design acceptance confirmation (DAC), as any design changes made to meet ONR's expectations could affect environmental aspects.
- If we are largely content with the environmental aspects of the design, we will provide the requesting party with an iSoDA that specifies the outstanding GDA Issues. We only do this if the requesting party can provide a realistic plan for addressing each of the GDA Issues. A full SoDA may replace an iSoDA once all the GDA Issues are resolved to the regulators' satisfaction.
- If we are not content with the environmental aspects of the design, we do not provide a SoDA or iSoDA to the requesting party. This would be the case where there is an unacceptable aspect of the design or an unacceptable omission in the information provided in the

submission. The requesting party may propose to undertake further work to address the problems and this might mean we can provide a SoDA at some future date.

Regulatory basis for GDA

38. We provide a SoDA/iSoDA as advice to the requesting party, in accordance with Section 37 of the Environment Act 1995 (GB Parliament, 1995) and the Natural Resources Body for Wales (Establishment) Order 2012 (as amended) (National Assembly of Wales, 2012). It has no other formal legal status. However, we will take full account of the work that we have done during GDA if we receive applications for environmental permits relating to a design that has been through GDA, if applications are based on the GDA submission.

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

- the disposal of radioactive waste (gaseous, aqueous and solid), under the Environmental Permitting Regulations 2016[1] (EPR16) (GB Parliament, 2016b)
- the discharge of aqueous effluents containing non-radioactive substances to surface waters and groundwater, under EPR16
- the operation of certain conventional plant (for example, combustion plant used as auxiliary boilers), under EPR16
- the disposal or recovery of non-radioactive waste, under EPR16
- the abstraction of water from inland waters or groundwater, under the Water Resources Act 1991 (WRA91) (GB Parliament, 1991)

40. It will also state our view on the acceptability of the design with respect to the environmental requirements of the Control of Major Accident Hazards Regulations 2015 (COMAH15) (GB Parliament, 2015).

41. Our GDA process mainly focuses on matters relevant to the disposal of radioactive waste. This is because:

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

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

43. New nuclear power stations are likely to need new or enhanced flood defence structures that will require a flood risk activity permit under the Environmental Permitting Regulations 2016. As the aspects of flood defence which lie within the remit of the environmental regulators is necessarily site-specific, we do not consider this matter during GDA.

GDA for the UK ABWR

Initiation and initial assessment

44. Our process for the first stage of GDA for the UK ABWR is described in our report on our initial assessment (Environment Agency, 2014b). It is summarised below.

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[1] We began our preliminary assessments when the Environmental Permitting Regulations 2010 (as amended) (GB Parliament, 2010) were in force. Revised regulations, the Environmental Permitting Regulations 2016 (EPR16) came into force on 1st January 2017 (GB Parliament, 2016b) and our detailed assessments have been reviewed, and are issued, against EPR16. However, the revision of the legislation was a consolidation of amendments and there have been no changes that affect GDA.

- We set up agreements with Hitachi-GE to carry out GDA of the UK ABWR
- The JPO received Hitachi-GE's submission in December 2013
- With ONR we launched the 'comments process' in January 2014, enabling the public to view and comment on the submission
- We carried out our initial assessment and concluded, among other things, that we needed more information
- We published our report on our initial assessment in August 2014 (Environment Agency, 2014b)

Detailed assessment

45. We began our detailed assessment in August 2014. Where practicable at the generic level, our assessment has taken account of the standards and legal and policy issues set out in government and Environment Agency guidance available on the gov.uk webiste:

Radioactive substances regulation for nuclear sites

Radioactive and nuclear substances and waste

The submission

46. We carried out our assessment using the information Hitachi-GE provided in a set of documents referred to as 'the submission'. These documents are listed in Schedule 1 of the SoDA which is set out in Appendix 1. The documents most relevant to environmental matters are listed in Appendix 3. As our detailed assessment has progressed we have taken account of additional information provided by Hitachi-GE and updates to the documents that make up the submission. These contain the additional information provided during the consultation phase in response to the 3 potential GDA Issues we had identified, and in response to our Regulatory Queries, Regulatory Observations and Regulatory Issue.

Scope of the GDA

47. The requesting party notes that the term 'UK ABWR' includes not only the reactor itself but also all buildings and connecting tunnels that are dedicated exclusively or mainly to housing systems and equipment related to the nuclear system, or which control access to those pieces of equipment and systems. There are 5 main buildings within the scope of the UK ABWR GDA:

- reactor building (including containment)
- turbine building
- control building
- radioactive waste building
- service building (structure only)

48. GDA has been based on a generic site layout of the above buildings, which may change for site-specific permit applications.

49. The main stack is located on the roof of the reactor building. This is the single release point for gaseous radioactive waste. Non-radioactive gaseous effluents from the emergency diesel generators are released from a separate release point.

50. There is a single discharge point for release of radioactive effluent to the sea.

51. Other minor sources for radioactive waste are excluded from the GDA scope. These include any discharges from:

- the service building
- the low level waste (LLW) management facilities
- the intermediate level waste (ILW) interim store

- the spent fuel (SF) interim store

52. Further details can be found in Hitachi-GE's ‘Generic site description’ submission.

Our assessment process

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

54. We have examined in detail the design documents that have been provided by Hitachi-GE. Where additional detail was required in order for us to complete our assessment, we identified this and requested further information from Hitachi-GE.

55. We raised and submitted Regulatory Queries (RQs) to request additional information and Regulatory Observations (ROs) where we identified a need for additional design work. We have tracked these and assessed the further design detail provided by Hitachi-GE as a result and continued this dialogue where necessary to reach an acceptable understanding and conclusion.

56. We held technical discussions with Hitachi-GE to ensure a full understanding of its design, to discuss points of clarification and to provide advice to resolve regulatory concerns.

57. We conducted relevant site visits (for example, to other ABWR sites) to see similar designs in later stages of development and construction that helped to inform our assessment.

58. We consulted widely and have carefully considered all the responses to our consultation, including raising further RQs and ROs to explore further details where necessary.

59. We have reviewed and considered comments raised and Hitachi-GE’s responses to relevant comments through the online comments process.

60. We have updated our assessment reports to take into account the above considerations and to inform our overall decision on the acceptability of the design.

Liaison with ONR and other bodies

We have worked closely with ONR throughout GDA. This enables us to achieve a balance between environmental, safety and security issues in relation to radioactive waste. We have considered its Step 3 and Step 4 reports, available on the ONR website. We have taken account of ONR findings in our assessments. ONR has published its design acceptance confirmation (DAC).

Final assessment reports

61. We have documented our detailed assessment in a series of assessment reports. These are listed in Chapter 4 and summarised in Chapters 5 to 18 of this document. The final assessment reports are revisions of the documents that we published to support the consultation. The updated final assessment reports reflect:

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

Consultation

62. The aim of GDA consultation is to help inform our assessment of new nuclear reactor designs by sharing information with people, and by listening to and carefully considering their input in our decision making.

63. It always remains our responsibility to make decisions about the acceptability, or not, of a reactor design, but we consider that our decisions are better informed through consultation.

64. Our aim is to build and maintain confidence in our decision making processes for GDA through our public involvement process, our consultation and our ongoing engagement. We work openly and transparently, subject to commercial and security sensitive constraints. We have deliberately made this assessment consultative because this helps build confidence in us and the process. At and during consultation we emphasisied that we had not made any final decisions and would not do so until we had carefully considered all the responses to the consultation.

65. The GDA process was designed to reflect the environmental regulators' normal processes for applications for nuclear site permits. Consultation is normal practice for the Environment Agency and Natural Resources Wales when dealing with applications for nuclear site permits. Our approach to consultation is in line with the government's published consultation prinicples.

66. At the start of our assessment of the UK ABWR we published a document setting out our high-level approach to engagement. It reflects our principle of 'working with others'. We believe that 'by working closely with and listening to partners and communities, we can improve the environment, protect more people and promote sustainable growth. We make better decisions when we take account of local opinions and draw upon the diverse strengths of others.'

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

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

Consultation documents

68. We published our consultation document (Environment Agency and Natural Resources Wales, 2016a), including an executive summary, for the Hitachi-GE nuclear power plant design. These were published on our websites and hard copies were available, including Welsh bilingual versions. These included specific questions which we were seeking responses to.

69. To help the consultation process, we also included in the consultation document a draft interim statement of design acceptability for the UK ABWR based on our preliminary (that is, before consultation) view.

70. For this consultation we provided a number of documents of varying levels of complexity:

- technical assessment documents (we recognise that specialist knowledge of the nuclear industry is needed to understand these documents)
- consultation document (a mixture of technical information and summaries at the start of each chapter)
- summary (aimed at a wide audience with some previous knowledge)
- web copy and a briefing note (aimed at a wide audience with some basic knowledge)
- infographics (straightforward information for those with no previous knowledge)

Additional information received since the consultation commenced

71. As noted in the consultation document, we expected to receive additional information from Hitachi-GE to address the concerns and outstanding matters that we had raised. We highlight in this decision document and the assessment reports where we have received additional information that has informed our decision on the acceptability of the UK ABWR design. We also refer to the relevant part of Hitachi-GE's consolidated submission where the additional information may be seen.

72. When reviewing this additional information, we have also carefully considered whether it should be made available to consultees so that they have an opportunity to consider the information and our views on it before we make our decision. We concluded that the additional information was not significant enough to require further consultation. In coming to this conclusion, we are mindful that consultation on relevent permit applications and on our proposed decisions would be carried out when or if the site-specific proposals are brought forward.

Raising awareness of our consultation, keeping people informed and our engagement

73. Before our consultation began we wrote and talked to national stakeholders and local representatives, near Wylfa Newydd and Oldbury. We informed them about our assessment work and asked them how they wanted to be involved in our consultation process. They provided feedback about their communities, the channels they use to read information and their preferred methods of engagement. After considering their responses we published our consultation plan.

74. We set out our objectives for consultation in the plan. We wanted to make sure that stakeholders:

- understand how we assessed the reactor design
- understand the findings of our assessment
- have an opportunity to give us their views
- know what will happen next
- can help make our final decision on the acceptability of the reactor design as robust as possible

75. We consulted on our preliminary conclusions, following our detailed assessment so far, for 12 weeks, from 12 December 2016 to 3 March 2017. We stated that we would carefully consider respondents' views in reaching our final decision on whether to issue a statement of design acceptability.

76. We believe that the level of local engagement was proportionate for our assessment of this design. We are confident that we did all we should do to properly consult and that this consultation was accessible to, and clearly targeted at, the people and organisations it was intended for. We are grateful to all who took the time to contribute and to attend our consultation events in both England and Wales.

77. To raise awareness about the consultation and to encourage participation we:

- wrote to people on our stakeholder databases by email. Our databases include national organisations and people who live near to the Oldbury and Wylfa Newydd sites such as parish and local councils, non-government organisations (NGOs), environmental groups, professional institutions, nuclear and environmental academics, the nuclear industry and trade unions
- published information and all consultation and assessments documents on gov.uk and Natural Resources Wales website and added links to these websites from the regulators joint website
- provided an easy-to-use e-consultation tool which hosted our documents and enabled an on-line response
- provided a plain English, high-level summary in html on GOV.UK and a paper copy for events. In this we were clear about the consultation process, what was being proposed and the scope to influence
- updated relevant Members of Parliament and Assembly Members through briefings

- posted paper copies of the consultation document, summary and addendum to stakeholders close to both sites. Documents could also be viewed in person at Environment Agency offices in Tewkesbury, Bridgwater and Bristol, and Natural Resources Wales offices in Bangor
- advertised the consultation in local newspapers (Bristol Evening Post, Gloucestershire Gazette, The Forester), which could be read by people living near to the Oldbury site in South Gloucestershire and similarly (Daily Post, Holyhead and Anglesey Mail, Western Mail) for people living near to the Wylfa Newydd site in Anglesey
- issued press releases to trade, national and local (near Oldbury and Wylfa Newydd) media. This resulted in several articles in print and digital media
- used social media (Twitter, Linked-in) to promote links to our consultation pages and the time and location of drop-in events in Thornbury and on Anglesey
- blogged on GOV.UK
- sent posters to libraries and other public locations near Horizon Nuclear Power's sites
- produced information leaflets and event stands for use at local events
- used infographics to explain our role and process
- updated subscribers to the joint regulators' GDA eBulletin and through the periodic report
- worked with third parties and advocates, securing their support to raise awareness. Examples include:
    - South Gloucestershire Council
    - Turnberrie's community centre, Thornbury
    - Stonehouse town council website
    - notices in parish magazines and websites
    - notices in industry media such as the Nuclear Industry Association
    - notices on Assembly Member and Member of Parliament's social media
- added information to Horizon Nuclear Power's December 2016 newsletter, which is delivered to around 16,000 homes on both sides of the Severn and distributed to one-stop-shops and libraries in South Gloucestershire, the Forest of Dean and Stroud District Council
- provided information about our consultation to both Horizon and Hitachi-GE for them to use in their communications to promote the consultation
- used internal communications channels to brief our staff and make those closest to the sites aware that there would be more local interest in their areas

78. In Wales our materials were bilingual.

79. To engage directly with stakeholders during consultation we:

- organised a national stakeholder seminar on 24 January 2017 in Birmingham
    - Around 70 stakeholders attended the seminar, representing a wide range of organisations such as local councils, industry and NGOs
    - We provided speakers and representatives with expert technical knowledge of the assessment process and nuclear power stations
    - The day involved a mix of presentations and opportunities to discuss the issues raised, have questions answered and to feed back views
    - The seminar was independently facilitated by Richard Harris from 3KQ
    - We collected questions and comments throughout the day. We took these away and responded to them after the event, issuing a short report to attendees on 28 February 2017
    - The responses and views from this event helped to inform our final decisions

- organised local stakeholder briefings and drop-in sessions on Anglesey and in Thornbury, South Gloucestershire
    - o Natural Resources Wales hosted an afternoon and evening public drop-in session at David Hughes Hall, Cemaes on 30 January 2017
    - o Natural Resources Wales, the Environment Agency and ONR presented to the Wylfa Site Stakeholder Group (SSG) at Magnox's Wylfa site on 30 January 2017
    - o Natural Resources Wales hosted an afternoon and evening public drop-in session at the Ebenezer Centre, Llangefni on 31 January 2017
    - o The Environment Agency hosted a morning and evening stakeholder briefing in Thornbury on 7 February 2017
    - o The Environment Agency hosted an afternoon and evening public drop-in event in Thornbury on 8 February 2017
    - o These events were advertised widely to our stakeholders by email, in the local media and on posters. The objective was to share our findings directly with stakeholders, respond to questions and gather initial views on the findings
    - o We have considered all the views and questions recorded at the events in reaching our decision
    - o Natural Resources Wales did not hold events in South Wales as there was no demand for events. Natural Resources Wales did not receive any response to its offer from stakeholders in South Wales following direct mail and social media advertising. It did, instead, contact stakeholders in South Wales and inform them that events were being held by the Environment Agency at Thornbury. Natural Resources Wales' staff attended the events in Thornbury to answer questions related to Wales
- offered briefings to site stakeholder groups and other fora around existing nuclear power stations
    - o Oldbury Site Stakeholder Group on 2 November 2016
    - o Wylfa Public Liaison Group on 20 October 2016
- attended or spoke at conferences and events organised by others, examples include:
    - o BEIS NGO forum on 19 December 2016
    - o Nuclear Industry Association conference on 1 December 2016

80. Our national stakeholder event, and local briefings and drop-ins provided people with an opportunity to come along and ask the experts about what was written in the documents, particularly if they did not understand, wanted clarification or to challenge.

81. To assist in promotion of the consultation Hitachi-GE and Horizon Nuclear Power:

- voluntarily participated in consultation events, providing speakers for national and local events and exhibition materials
- made a media announcement at the start of consultation
- provided a broadcast interview in support of local events

82. To make the consultation as accessible as possible we made it available on our website and invited people to respond directly online.

83. Approximately 40% of those who responded used our online tool. We are evaluating their experience so that we can learn lessons for future use and development of our online consultation tool.

84. To update stakeholders on progress following consultation we:

- published a compilation of all the responses to our consultation on GOV.UK on 13 July 2017

- emailed our stakeholders to let them know we had published this and that they still had time to contribute via the ‘comments process’

85. We received 35 responses to the consultation. We list the names of all the organisations that responded to the consultation in Appendix 6 of this decision document. We have not given names of individuals or members of the public. The list gives a GDA number to each response (for example, ABWR-33 is for the Food Standards Agency), so that this document and the assessment reports can be searched to allow all respondents to see where their responses have been considered. Where we quote consultation responses directly in this document, we have not generally corrected spelling or grammar. Similarly, where responses referred to our consultation questions by the wrong question number, we have not corrected the respondent's numbering.

86. Other comments and questions were also raised at our face-to-face engagement events and we have considered these in this decision document.

87. Some responses raised comments about the consultation process. All responses are listed in Appendix 7 together with our replies in each case.

88. Thank you to all who took time to contribute. We considered all the responses to our consultation and ONR’s assessment before coming to a final decision on the acceptability of the design.

Public comments process

89. We ask all nuclear power station design companies who enter the GDA process to set up a website and publish information about its design, invite comments and questions about the design, and respond to those comments and questions.

90. This continuous ‘comments process’ was available to anyone throughout our assessment of Hitachi-GE’s UK ABWR on the company’s website. The company updated information on the website throughout GDA and it contains all the information submitted to the regulators, except that which is commercially confidential or subject to national security restrictions.

91. The process opened on 6 January 2014 and continued throughout GDA until 15 August 2017. To complete our assessment of the reactor designs by December 2017, we needed to receive any comments on the designs in sufficient time to reflect them in our decision document (and ONR’s Step 4 reports). To enable this, the comments process closed on 15 August 2017, around 4 months before we made our decision.

92. Hitachi-GE received and responded to 83 comments. We saw the questions and Hitachi-GE’s responses and used them, where relevant, to help inform our assessments.

Where they relate to our areas of interest, our detailed assessment has taken account of comments received and Hitachi-GE's responses to those comments submitted up to 15 August 2017.

Promoting our work about GDA to the public and interested groups

93. We have continued to raise awareness of GDA and the opportunity to comment by:

- meeting with stakeholder groups (including NGOs, local councils, site stakeholder groups for existing nuclear sites). Our regulators’ specialist knowledge has been available to the public and stakeholders throughout the assessment. Meetings include:
    - Horizon Wylfa Newydd Project Liaison Group (PLG)
    - BEIS NGO forum
    - Oldbury and Berkeley Site Stakeholder Groups
    - attending Horizon Nuclear Power’s Development Consent Order (DCO) stage 2 consultation events to explain our (Natural Resources Wales') role
- targeting nuclear and environmental academics
- answering questions from journalists and providing information for media articles

- explaining our work at national conferences and seminars such as Marketforce, Nuclear Industry Association and Nuclear Institute events
- providing clear, accessible information available on our websites
    - Environment Agency
    - Natural Resources Wales
    - Joint regulators website
- publishing regular updates about our work to resolve Regulatory Issues (RIs) and the status of Regulatory Observations (ROs) through quarterly reports on the joint website
- issued updates through the joint regulators' e-bulletin to subscribers and the Environment Agency's and Natural Resources Wales' own stakeholder e-bulletins
- published leaflets and used social media

94. Hitachi-GE has also raised the profile of the comments process by:

- setting up and maintaining a website
- promoting the launch of Step 2 with a press announcement, creating a promotional flyer, letters to UK local councils, Members of Parliament, Welsh Assembly Members, libraries in Wales and South Gloucestershire, Anglesey councillors, relevant government officials and others
- featuring the comments process in presentations to industry groups, learned societies, the Wylfa Newydd Project Liaison Group, and wider stakeholders throughout its operational lifetime
- highlighting its presence in a range of media announcements and public talks and conferences
- promoting the closure date via the website and included in the ongoing references within presentations

95. Horizon Nuclear Power further promoted the comment process closure through social media.

Research

96. During 2014 to 2016, we worked with Sciencewise to help us understand how the public want to be involved and consulted about our assessment of new nuclear power station designs. The findings from this work, along with other evaluation and research, informed our communications and engagement plan for our consultation on the UK ABWR.

97. Our research with Sciencewise highlighted the work we are doing to improve public involvement in and accessibility to a complex and technical subject. It's important to us that we provide different levels of material to enable anyone to get involved and engaged with our work. We follow a style guide, which is used across government and worked with a plain English technical editor. We encourage feedback from those who read the documents on readability and style so that we can work to improve future documents.

98. For this consultation we provided a number of documents of varying levels of complexity:

- technical assessment documents - for those with specialist knowledge of nuclear power stations
- consultation document - a mixture of technical information with summaries at the start of each chapter
- summary - for a general audience with some previous knowledge
- web copy and a briefing note - for a wide audience with some basic knowledge
- infographics - straightforward information for those with no previous knowledge

Evaluation

99. Evaluation is important to us and enables us to learn lessons and share our experiences with others. We are evaluating the effectiveness of our communications and engagement and will use the findings to inform our work on future GDAs.

- Our communications and engagement activity is evaluated internally in line with the Government Communications Services evaluation framework.
- Our GDA consultations are also evaluated by an external independent organisation. The evaluation of this consultation will be published in spring 2018.

Future opportunities for engagement

100. There are further opportunities for engagement and input into our decision making process when Horizon Nuclear Power applies for environmental permits from Natural Resources Wales (Wylfa Newydd) and the Environment Agency (Oldbury). Before we consult we will ask communities and local organisations how they would like to be involved in our decision making.

101. A DAC and SoDA confirms the regulators consider a power station based on the design could be built and operated at a site in England and Wales. But before that could happen a company that wants to build and operate a new nuclear power station must obtain a number of site-specific permissions from the nuclear regulators. In addition, other planning permissions are also required. When making decisions about site-specific permit applications the regulators will take account of all the work done during generic design assessment.

102. The Environment Agency and Natural Resources Wales are responsible for a range of environmental permits relating to the construction and operation of nuclear power stations and also for relevant ‘associated developments’ such as workers’ accommodation. These include permits for radioactive discharges, cooling water discharges and the operation of stand-by generators. We will decide if the permits should be issued and, if so, what conditions should apply.

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

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

105. The first site-specific application under EPR 2016 radioactive substances regulation for a UK ABWR has now been received by Natural Resources Wales. The application was submitted by Horizon Nuclear Power relating to a UK ABWR on land adjacent to the exisitng nuclear power station at Wylfa, on Angelsey. Subsequent related applications are expected:

- To the Planning Inspectorate for planning permission
- To the Office for Nuclear Regulation for the nuclear site license
- To Natural Resources Wales for permits relating to water discharges, combustion activities and construction activities

Post consultation review

106. We have acknowledged all the responses, but we did not generally enter into further correspondence with those who had responded.

107. We have carefully considered each response that we received. A number of responses to our consultation, and in particular to question 16, raised matters outside the scope of GDA and sometimes outside our regulatory remit. These comments are summarised in Appendix 7.3, with a short note as to why we are not considering them in our GDA. Examples include:

- site-specific concerns
- safety, security and transport matters
- government policy or other government facilitative actions
- matters associated with planning
- matters associated with the development of a geological disposal facility (GDF) and the Managing Radioactive Waste Safely (MRWS) programme

108. Where matters arose that fell outside our responsibilities, we passed them to the appropriate regulator, government department or public body. We have listed these in Appendix 7.4.

Decision and statement

109. In the light of all the information obtained, including that which we received during and after our consultation, we have decided to issue a statement of design acceptability (SoDA).

110. A part of our reaching this conclusion was that the 3 potential GDA Issues we had identified prior to consultation have now been resolved by Hitachi-GE to our and ONR's satisfaction. No further GDA Issues have been identified subsequently.

111. This decision document:

- sets out the basis for our decision
- summarises the consultation responses and issues raised
- sets out our views on those issues that fall within our responsibilities and how they have helped inform our decision making. For responses relating to issues falling outside our responsibilities, we have identified the government department or public body to whom we have passed them

112. Our SoDA states our view on the acceptability of the design to be permitted, under the relevant environmental legislation, for:

- the disposal of radioactive waste (gaseous, aqueous and solid)
- the discharge of non-radioactive substances to water (excluding heat, which is out of GDA scope)
- the operation of combustion plant (for example, emergency generators or auxiliary boilers), where they come under UK legislation

113. Our view on the acceptability of the design with respect to the environmental requirements of the COMAH regulations is also stated.

114. Our joint guidance with ONR on the regulatory process for GDA (Joint Regulators, 2013) sets out the process by which we reach our GDA conclusions and the possible outcomes. While we make separate decisions on the acceptability of the reactors, we are clear that we would require both the ONR design acceptance confirmation (DAC) and our SoDA, to refer to the same design reference. We note that ONR have also reached a decision to issue a DAC for the UK ABWR.

3. The UK Advanced Boiling Water Reactor design

This chapter provides a brief description of the UK Advanced Boiling Water Reactor (UK ABWR) design and how it is proposed that waste will be created, processed and disposed of.

Outline of design

115. The UK ABWR design is for a single boiling water reactor (BWR) capable of generating 1,350 megawatts (MW) of electricity. In the reactor core, the uranium oxide fuel (enriched to less than 5% by weight of uranium-235) is cooled by water, which also acts as the neutron moderator necessary for a sustained nuclear fission reaction. The water boils, producing steam, which directly drives a turbine-generator to produce electricity. The steam is then condensed, and the condensate returned to the reactor. The system is shown in Figure 3.1 below.

116. The main ancillary facilities include a spent fuel storage pool, spent fuel store (final option to be determined at site-specific stage), water treatment systems for maintaining the chemistry of the water circuit, 2 alternative alternating current (AC) generator systems plus an emergency back-up for providing power in the event of loss of grid supplies, and waste treatment and storage facilities. Turbine condenser cooling water is provided by a once-through system. For GDA, Hitachi-GE proposes seawater for cooling water.

117. The International Atomic Energy Agency (IAEA) Power Reactor Information System (PRIS) database notes that there are 4 units of the ABWR already operating in Japan, with a further 4 units being built in Japan and Taiwan. Nuclear regulators in the USA, Japan and Taiwan have carried out a design assessment of the ABWR design. The design has evolved from earlier Hitachi-GE BWR designs and the Asea Brown Boveri (ABB) design, transferred under licence to Hitachi-GE/Toshiba. The most recent reactor of similar design is the BWR-6. Currently, there are 8 of these units operating around the world.

Figure 3.1 - Diagram of the UK ABWR

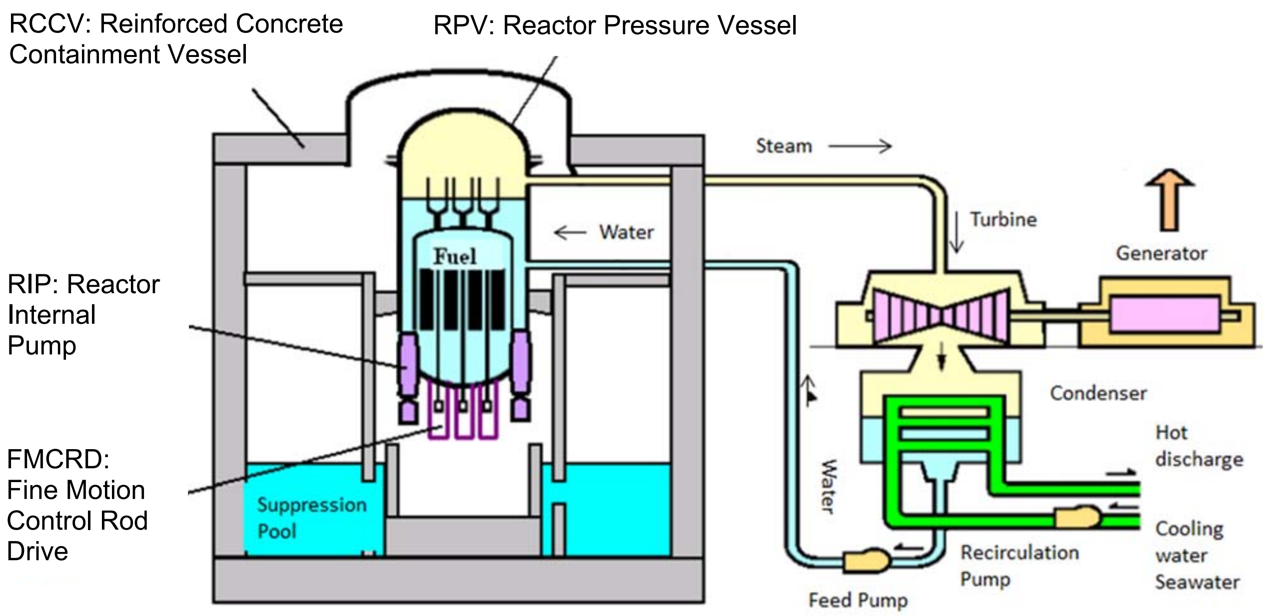

Image courtesy of Hitachi-GE

Sources, processing and disposal of radioactive waste

118. Radioactive waste is created from activities associated either directly or indirectly with operating and maintaining the reactor, and ultimately, from decommissioning the power station. In particular, operating the UK ABWR generates radioactive waste in the water of the reactor coolant circuit.

119. Liquid radioactive discharges arise from the high chemical impurity waste (HCW) system and the laundry drain (LD). The HCW feeds originate from a range of drains and sumps within the service building and from the laboratory drain. The HCW system will also treat liquids from the Controlled Area Drain (CAD), but only in the event that radioactivity is detected when sampled. Liquid effluents from the treatment of the reactor coolant are reused via the condensate storage tank and not discharged. Facilities to monitor all effluents prior to release are provided.

120. The main source of gaseous radioactive waste is also generated within the reactor coolant circuit. This is collected by the off-gas system (OG) and held for decay storage in the carbon bed delay system. Gaseous activity will also be present in the main process buildings, which are serviced by the heating, ventilating and air-conditioning systems (HVAC). Discharges from these systems are via a high level stack located on the top of the reactor building. There is provision for monitoring these discharges after filtration.

121. Radioactive wastes that are not discharged directly to the environment include spent ion exchange resins, spent filter media, worn-out plant components and parts, contaminated protective clothing and tools, rags and tissues, and potentially contaminated waste oil. Facilities for managing these types of solid waste include resin storage tanks and storage areas for packaged low-level and intermediate-level radioactive waste. Space has been included for treating and packaging solid wastes in these facilities. All radioactive plant components are likely to become waste when the power station is decommissioned. Similar wastes generated in the UK at present are disposed of at the national Low Level Waste Repository (LLWR) in Cumbria or stored pending disposal at a future deep geological disposal facility (GDF).

122. Spent fuel will be stored under water for several years in the spent fuel storage pool. The design includes provision of a store to allow further interim storage prior to final disposal when an appropriate UK facility is available.

Non-radioactive waste

123. Non-radioactive wastes are generated from operating and maintaining the 'conventional' side of the power station. They include:

- combustion gases discharged to air from the auxiliary boilers and back-up generators
- water containing water-treatment chemicals from the turbine-condenser cooling system and other non-active cooling systems, which is discharged to sea
- waste lubricating oils
- debris from the sea inlet screens
- worn-out plant and components and general waste

124. Further information on managing non-radioactive waste will be provided in future submissions from a future operator during site-specific permitting.

125. Non-radioactive substances will also be present in the radioactive wastes and may affect the management or environmental impact of those wastes.

4. Guide to our detailed assessment

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

Detailed assessment topics

126. In the following Chapters 5 to 18, we set out our conclusions for:

- management systems (Chapter 5)
- radioactive substances regulation topics
    - strategic considerations for radioactive waste management (Chapter 6)
    - process for identifying best available techniques (BAT) (Chapter 7)
    - preventing and minimising the creation of radioactive waste (Chapter 8)
    - gaseous radioactive waste (Chapter 9)
    - aqueous radioactive waste (Chapter 10)
    - solid radioactive waste (Chapter 11)
    - monitoring discharges and disposals of radioactive waste (Chapter 12)
    - impact of radioactive discharges (Chapter 13)
- other environmental regulation topics
    - water abstraction (Chapter 15)
    - discharges to surface waters and groundwater (Chapter 16)
    - operation of installations (Chapter 17)
    - control of major accident hazards (Chapter 18)

127. The detailed assessments provided in Chapters 5 – 18 are essentially the same as those provided in the consultation document but updated, where necessary, to reflect:

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

128. Our conclusion on the acceptability of the design for radioactive substances permitting is set out in Chapter 14 and that on the overall acceptability of the design in Chapter 19.

129. A full description of our detailed assessment can be found in our separate assessment reports:

- AR01 - Assessment of management arrangements
- AR02 - Assessment of the strategic approach to waste management
- AR03 - Assessment of best available techniques
- AR04 - Assessment of gaseous radioactive waste disposal and limits
- AR05 - Assessment of aqueous radioactive waste disposal and limits
- AR06 - Assessment of solid radioactive waste and spent fuel
- AR07 - Assessment of sampling and monitoring

- AR08 - Assessment of generic site description
- AR09 - Assessment of radiological impacts on members of the public
- AR10 - Assessment of radiological impacts on non-human species
- AR11 - Assessment of other environmental regulations

About our conclusions

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

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

Therefore, these matters cannot be addressed during GDA so are carried forward for consideration at the appropriate time.

5. Management systems

This chapter covers our assessment of Hitachi-GE's management systems. A management system is 'the set of procedures an organisation needs to follow in order to meet its objectives'. It includes identifying the necessary organisational resources, responsibilities and capabilities.

We conclude that Hitachi-GE has an appropriate management system in place that will:

- ensure the design achieves high standards of protection for people and the environment
- support the requirements set out in our process and information document (P&ID) (Environment Agency, 2016b)
- control the content and accuracy of the information provided for GDA
- maintain records of design and construction
- control and document modifications to the design
- have adequate suitably qualified staff to support production of the GDA submission

We conclude that Hitachi-GE will have an adequate process in place to:

- inform any operating utility's management system
- transfer knowledge and provide continuing support to any operating utility

Please read below for a summary of our detailed assessment and links to further supporting documents.

Matters arising from our initial assessment

131. We examined Hitachi-GE's quality assurance/management system arrangements in some detail during our preliminary assesment in 2013 to 2014 and concluded that it was suitable for controlling the accuracy of the information Hitachi-GE provided to us for GDA.

132. Hitachi-GE describes its management system in its GDA project plan, quality plan, compliance table and GDA specific procedures.

133. We noted that Hitachi-GE's management arrangements were certified to ISO 9000, 14000 and 18000 series of standards.

134. We reviewed the Hitachi-GE quality plan and supporting documents, which set out the expectations for quality control requirements for the project. It also identified the requirements for compliance with our P&ID (Environment Agency, 2016b) and incorporated required references to our radioactive environmental principles (REPs) (Environment Agency, 2010).

135. We checked the process documents to ensure they identified the requirements of the P&ID relevant for this stage of the project and our REPs and guidance documents.

136. With ONR, we visited Hitachi-GE's offices in Hitachi City, Japan, for a 4 day joint inspection to see how the management system worked in practice. The inspection objectives were to:

    - check that Hitachi-GE has a quality management system (QMS) that provides organisational and procedural arrangements that adequately support production of the submissions
    - establish that Hitachi-GE has implemented and continues to review arrangements that adequately control its GDA-related activities

- inform the regulators' assessment of Hitachi-GE’s submission

137. Over the 4 days, we examined samples of the QMS procedures and other documentation, and held discussions with relevant staff. Hitachi-GE is certificated to ISO 9001,14001 and 18001, so this inspection concentrated on the processes that will deliver the GDA. These arrangements were generally of a good standard.

138. Our main findings are summarised below:

- Document control arrangements were of a good standard.
- The format and content of documents were suitably specified and arrangements were in place to submit documentation to the Joint Programme Office for assessment by the regulators:
    - We found a number of minor discrepancies
    - Records were well specified and kept
    - We judged the document control arrangements to be satisfactory
- We found the design change control arrangements for developing the UK ABWR reference design from a Japanese reference plant were satisfactory. The level of design review, verification and validation appeared appropriate.
- Arrangements are in place for the review, independent verification and approval of safety and environmental documentation prior to submission to the regulators. We considered these arrangements to be satisfactory.
- Hitachi-GE has arrangements in place for requesting that design changes are included in GDA after the design reference point (DRP) and for receiving regulatory agreement.
- We examined suitably qualified and experienced personnel (SQEP) records for Hitachi-GE personnel, contractors and consultants that demonstrated that the personnel were competent for their roles. SQEP records were of a good standard. We judged this to be satisfactory.
- The control of suppliers included an approved suppliers list, supplier evaluation and a good standard of procurement documentation. Records for supplier evaluations were readily available and complete. We judged these arrangements to be satisfactory.
- Independent assessment of the GDA process consisted of an audit programme. The first part of the programme for ONR's Step 2 and our initial assessment had been completed and all corrective actions carried out and verified. These audits focused on system requirements. We made a recommendation to focus the next round of audits on GDA submissions and supporting documents and to carry out the audits near the start of the next stage of GDA, to allow time for changes to be made.
- During the visit, we held additional meetings to clarify and agree how the UK ABWR reference design will be specified at the DRP and in the master document submission list (MDSL). Hitachi-GE suggested a ‘design reference document list’ or ‘reference plant’ document listing approximately 2,000 system descriptions and drawings as the basis for the design reference. This document would also indicate the Japanese reference plant from which the UK systems were developed. We and ONR indicated that we are content with the proposal.
- Hitachi-GE agreed to include the arrangements for controlling the GDA contact list in the document control manual.
- Hitachi-GE agreed to include RQs, ROs and other documents, for example management surveillance and quality assurance procedures, to the submission tracking sheet.

139. A joint Environment Agency and ONR RQ was raised with Hitachi-GE to address the main findings of the inspection (RQ-ABWR-0092). This was set out in our Environment Agency initial assessment report (Environment Agency, 2014b).

140. We did not identify any potential GDA Issues or Assessment Findings during our preliminary assesment. However, as discussed above, we did identify some minor areas for improvement:

- Hitachi-GE to improve clarification of responsibilities within the verification process.
- Implement the RQ resolution process.
- Extend the Hitachi-GE internal audit programme to cover all aspects of GDA arrangements.
- Hitachi-GE to improve the design review process to clarify how best available techniques (BAT) are discussed and considered during design review meetings and how this is recorded in the minutes.

141. The requirement to record requirements to carry out BAT assessments has now been completed.

142. Radioactive waste advisers (RWAs) had not been appointed at the time of the inspection. However, examination of role profiles indicated that relevant staff had received training on our requirements and the use of BAT. In our view, that was sufficient at that stage of the project. Hitachi-GE has subsequently employed a UK RWA to provide UK legislative advice and to support Horizon Wylfa Ltd staff.

143. Hitachi-GE has acted on our recommendations. We reviewed this during the detailed assessment stage and are content they have been acted upon.

Other aspects of our detailed assessment

144. During the detailed assessment stage, we continued to communicate regularly with Hitachi-GE via videoconferencing and made several visits to Hitachi-GE works in Japan to gather evidence that changes have been embedded and remain effective. This enabled us to continue to review Hitachi-GE's progress and provide advice on improvements where necessary. This engagement confirmed that Hitachi-GE have acted on inspection findings.

145. Our review of Hitachi-GE's submissions has included how Hitachi-GE has implemented its GDA project plan and the supporting project quality plan (PQP). The PQP describes the arrangements for quality assurance, environmental and safety management activities during GDA. It includes project instructions and procedures that were specifically developed for the UK ABWR GDA project. These include arrangements for control of documents, data and records, design change, management responsibility, resource management and reporting non-conformances.

146. Hitachi-GE has regularly revised its PQP to reflect developments in the project organisation and associated documents and instructions.

In October 2014, the joint regulators visited Hitachi-GE Japan works offices to review the results of Hitachi-GE internal audits, to discuss updates to the management system and review the implementation of the commitment capture process. We found no significant issues. The visit also included discussions on the requirements for transferring the technology to a future operator. We captured observations made during the visit in a Regulatory Observation (RO-ABWR-0057). This was published on the joint regulators' website in June 2015 and the progress is discussed in our assessment report [AR01 - Assessment of management arrangements].

147. ONR and the Environment Agency carried out a further visit to Hitachi-GE Japan works offices during the detailed assessment stage of GDA in April 2015 to investigate the effectiveness of the training given to support both pre-construction safety report (PCSR) and generic environmental permit (GEP) BAT submissions. The visit included discussing and reviewing processes for recording actions raised as a result of dealing with any RO and RIs raised by all regulators during their assessment of topic areas. The joint regulators concluded that training should take place to improve understanding of UK requirements.

148. An RO (RO-ABWR-0058) was issued and published on ONR's website in June 2015.

149. Hitachi-GE put in place an action plan, which it implemented throughout 2015. It has also carried out an extensive training campaign.

150. ONR and the Environment Agency visited Japan in April 2016 to discuss progress in training all staff. We noted significant improvement in the number of staff trained by UK specialists since the last inspection. We found the training in UK environmental requirements satisfactory.

151. The visit also included reviewing the implementation of the GDA design review and change processes. We examined examples of how BAT assessments are included in the process and found this to be satisfactory.

152. Hitachi-GE has responded positively to the joint regulators' recommendations and has made changes to its processes.

153. We found no other major areas for improvement other than training, and we remain highly confident in Hitachi-GE's project arrangements.

154. We have met with the Hitachi-GE management systems/quality assurance team throughout the project to review progress on actions from our visits and its own internal audit reviews.

155. We published an assessment in December 2016 in support of our consultation. We have continued to work with ONR on the agreed plan for examining Hitachi-GE processes for the ongoing period up to the end of the GDA process.

156. In October 2016, the joint regulators visited Hitachi-GE Japan works offices to carry out further investigation into compliance. We summarised our findings in a RQ (RQ-ABWR-1233). We have had several further meetings with Hitachi-GE management systems quality assurance (MSQA) staff and carried out further sampling of evidence available in the UK and Japan, to keep compliance with the P&ID under review.

Expectations for the operator's management system

157. During the detailed assessment stage we reviewed the development of the process for technology transfer to licensee and operating regime, which was raised as RO-ABWR-0057 Action 3 (published on ONR's website).

158. Hitachi-GE proposes to provide a future operator with a suite of documents that will include basic design and construction criteria, technical specifications, equipment manuals (including surveillance requirements), unit and system operation manuals, incident management arrangements, design control and design authority arrangement. It is our view that this proposal will meet the requirements of the P&ID for informing a future operator's operating instructions.

159. Hitachi-GE has also developed arrangements for identifying the claims, arguments and evidence to help the future operator develop site-specific safety cases and environment cases throughout the life cycle of the plant.

- Claims are clear statements of what will be achieved, and demonstrate compliance with the requirements of the P&ID and those conditions in the generic permit that are subject to the application of BAT.
- Arguments consist of information presented to demonstrate that a claim is valid.
- Evidence is information to support claims and arguments. This may include operating measures and operational requirements.

160. It is our view that this process, as well as a database of assumptions made for GDA (named AIRIS+), is well developed and has been used during the detailed assessment stage to capture this information as it is identified. This will be passed to a future operator to ensure key assumptions underpinning the generic environmental permit (GEP) will be available to support a site-specific environmental permit.

Our overall conclusions on management systems

161. We conclude that Hitachi-GE has a management system in place that will:

- ensure the design achieves high standards of protection for people and the environment
- control the content and accuracy of the information provided for GDA
- maintain records of design and construction
- control and document modifications to the design
- have enough suitably qualified staff to support production of the GDA BAT case

162. We conclude that Hitachi-GE will have an adequate process in place to:

- inform any operating utility's management system
- transfer knowledge and provide continuing support to any operating utility

163. We have raised no GDA Issues or Assessment Findings in this area.

More details of our assessment of management arrangements are provided in our report [AR01 - Assessment of management arrangements] (Environment Agency, 2017a).

6. Strategic considerations for radioactive waste management

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

We conclude that:

- Hitachi-GE has provided an acceptable waste strategy for all waste streams that a UK ABWR will typically produce
- Hitachi-GE's integrated waste strategy (IWS), together with its other submissions, will help to protect human health and the environment
- the IWS is consistent with recent government policy statements (DECC, 2014a) and current regulatory expectations
- Hitachi-GE has appropriately demonstrated that the design of the UK ABWR to ensure waste arisings and impacts to people and the environment are minimised from decommissioning the UK ABWR.

We have identified 2 Assessment Findings:

- **Assessment Finding 1**: A future operator shall provide details of how the proximity principle has been applied in its demonstration of best available techniques for solid and incinerable liquid wastes prior to active commissioning.
- **Assessment Finding 2**: If appropriate, a future operator shall produce an assessment of best available techniques that covers all of its sites, noting economies of scale and other efficiencies in disposal of solid and incinerable liquid wastes across all of its sites before it starts active commissioning of the UK ABWR.

Please read below for a summary of our detailed assessment and links to further supporting documents.

Overview of the waste management strategy

164. We have carried out a detailed review of Hitachi-GE’s integrated waste strategy (IWS) and the documents that support it. The purpose of an IWS is to set the strategy for how wastes will be managed at all stages of a nuclear power station’s life cycle, from construction to operation and then to final decommissioning, and also how the plant is designed to minimise the amount of waste generated.

165. The IWS sets out how the requesting party intends to comply with government policy, legal obligations and industry good practice for waste management. The strategy considers the requirements of environmental legislation such as the Environmental Permitting Regulations 2016 and demonstration of best available techniques, through the application of the waste management hierarchy.

166. The requesting party's IWS outlines its current strategy for managing radioactive and non-radioactive waste, including spent fuel, generated throughout the plant life cycle from constructing, operating and decommissioning the UK ABWR. The strategy is supported by:

- radioactive waste management arrangements
- a decommissioning strategy
- methods for assessing best available techniques (BAT) and defining the approach to optimisation
- impact assessments for humans and wildlife

167. The IWS has been produced for a single reactor unit situated at a generic site. The strategy covers:

- solid radioactive wastes produced during operation and decommissioning
- solid non-radioactive wastes produced during construction, operation and decommissioning
- liquid radioactive wastes produced during operation and decommissioning
- liquid non-radioactive wastes produced during construction, operation and decommissioning
- gaseous radioactive wastes produced during operation and decommissioning
- gaseous non-radioactive wastes produced during construction, operation and decommissioning
- spent fuel, including the final core off-load during decommissioning

168. The first principle of the requesting party's IWS is to apply the waste hierarchy to all wastes and that this should be fundamental when considering subordinate strategies and processes. The IWS also sets out principles that propose to minimise the amount of waste created during construction, operation and decommissioning by using BAT to identify optimised solutions.

169. Although the GDA process allows us to formally ask the requesting party to clarify aspects of its submission, our discussions with Hitachi-GE throughout GDA have meant that we did not need to do this during the development of the IWS.

General approach to radioactive waste management

170. Our 'Radioactive Substances Regulation Environmental Principles' (REPs) (Environment Agency, 2010), at principle RSMDP1 (Radioactive substances strategy), indicate the matters to be considered at a strategic level.

171. Hitachi-GE's IWS seeks to apply the concentrate and contain principle to individual radioactive waste streams, including the balance between aqueous and gaseous discharges and the generation of solid waste streams. 'Concentrate and contain' options involve treating arisings of radioactive waste so as to secure its radioactivity in a solid, concentrated form for storage and eventual disposal. 'Dilute and disperse' options involve essentially the direct discharge of gaseous or aqueous liquid radioactive waste arisings, without treatment, into the environment where the radioactivity is diluted and dispersed (DECC, 2009).

172. Hitachi-GE's IWS summarises how it will manage radioactive waste through operation and decommissioning of the UK ABWR. It also describes how elements of the reactor's design allow wastes to be managed through their life cycle. We are content that Hitachi-GE has considered gaseous, aqueous, other liquid and solid radioactive wastes and that its approaches for each are technically sound, meet the necessary regulatory requirement and are consistent with current industry good practice.

173. The creation of radioactive waste is minimised in the UK ABWR by maintaining the integrity of the nuclear fuel, minimising materials whose physical properties make them prone to becoming very radioactive in a nuclear reactor and controlling the chemistry of the water coolant. This approach is known as 'managing the source term'. A secondary benefit of controlling the chemistry of the water

coolant is to minimise corrosion on the inner surfaces of the nuclear reactor plant to prevent the creation of 'mobile' contamination inside the plant.

174. The UK ABWR includes an engineered system for managing and cleaning up the gaseous waste stream prior to its discharge to the environment. This will further reduce the discharge of gaseous radioactivity. We provide further information in Chapter 9 of this document.

175. There are 2 main engineered systems that manage aqueous wastes in the UK ABWR. The first is provided to decontaminate and, where possible, recycle aqueous liquids containing radioactivity, while the second system processes aqueous liquid that cannot be recycled by further decontamination before it is discharged to the environment. We discuss this further in Chapter 10 of this document.

176. Hitachi-GE's IWS considers solid radioactive waste according to its categorisation of lower activity waste, higher activity waste or spent fuel. The strategy applies the waste hierarchy, avoiding creating solid waste where possible and minimising radioactive waste at source where this is not possible. The UK ABWR design includes facilities to sort, package and dispatch waste off-site where there is currently a disposal route, or to store it on site pending geological disposal. We discuss this further in Chapter 11.

177. Any 'strategy' that relates to a generic site and to how aspects of a nuclear facility should be operated by a future operator of that site, as is the case at GDA, has some necessary limitations. In the case of waste management, there are 2 main areas where the information submitted for GDA is less detailed than that we would expect for an operational facility.

178. Firstly, proximity of disposal: as the submission for GDA relates to a 'generic site' it could never be clear where the most suitable disposal facility for a given waste stream is relative to the UK ABWR in geographical terms. For example, for low level radioactive waste (LLW), it is possible that a suitable disposal facility may be located closer to the eventual site than the Low Level Waste Repository (LLWR) near Drigg in Cumbria.

179. Secondly, there are commercial factors that may influence the choice of disposal route for a particular waste and questions such as "does the eventual operator have multiple, similar plants?", "are there economies of scale to be considered in a holistic demonstration of BAT?", "could the eventual operator enter into a commercial arrangement to secure more proximate disposal?" have to be considered. Clearly for a 'generic site' for GDA, it would be unreasonable for regulators to expect these issues to be fully resolved.

180. Therefore, we consider this to be 2 distinct Assessment Findings.

- **Assessment Finding 1**: A future operator shall provide details of how the proximity principle has been applied in its demonstration of best available techniques for solid and incinerable liquid wastes prior to active commissioning.
- **Assessment Finding 2**: If appropriate, a future operator shall produce an assessment of best available techniques that covers all of its sites, noting economies of scale and other efficiencies in disposal of solid and incinerable liquid wastes across all of its sites before it starts active commissioning of the UK ABWR.

Higher activity waste and spent fuel

181. The government has indicated that new nuclear power stations should proceed on the basis that spent fuel will not be reprocessed, and that both spent fuel and intermediate level radioactive waste (ILW) will be disposed of at a geological disposal facility (GDF) (GB Parliament, 2011b). Since such disposals are unlikely to occur until late this century, this means that the strategy needs to consider on-site storage and management of both ILW and spent fuel for the lifetime of the power station, or an appropriate alternative that is consistent with UK government policy on the long-term management of higher activity radioactive waste (DECC, 2014a).

182. The IWS covers segregating and separating higher activity wastes (HAW) and spent fuel. It differentiates between 'solid HAW' that would cover metallic and other solid radioactive wastes and 'wet solid' HAW that would cover wastes such as contaminated ion exchange resins and process sludges.

183. Solid HAW will be segregated, packaged into a passively safe form and then stored until a GDF is available in the UK. Wet solid HAW will be conditioned by encapsulation in cement, also pending the availability of a GDF. The strategy sets out the requirement for inspection and maintenance of both solid and wet solid HAW once it has been conditioned and is being stored on site awaiting final off-site disposal.

184. After an initial period of cooling in the UK ABWR's spent fuel pool, spent fuel will be treated as if it were waste and will be appropriately packaged and stored awaing disposal to a GDF, which is consistent with the UK government 'base case' (GB Parliament, 2011b).

185. The arrangements set out in the IWS for HAW and spent fuel are consistent with UK government policy, regulatory expectations and industry good practice.

Decommissioning

186. In line with government policy (GB Parliament, 2004), we expect decommissioning of the station to be considered at the design stage, with a view to ensuring that it can readily be carried out, while minimising the volumes of decommissioning wastes and minimising the impacts on people and the environment. In essence, we expect new nuclear reactor designs to be designed to facilitate decommissioning and to support waste minimisation.

187. Hitachi-GE's IWS summarises the waste management strategy that should be employed when the UK ABWR is decommissioned. It acknowledges that the limits within an environmental permit during the decommissioning phase of a nuclear power station's life are likely to be different from those during operation. It highlights that an operator of a UK ABWR will need to act upon this. It lists which systems will no longer be needed as soon as electricity generation ceases and identifies these as candidates for prompt decommissioning. It also lists the systems that the UK ABWR used during operation which will be critical to sustaining decommissioning activities such as heating, ventilation and air conditioning, liquid effluent systems and solid waste facilities.

188. The IWS provides estimates of waste volumes during decommissioning. This allows the eventual operator to consider waste volumes and costs and to make adequate provision for decommissioning well ahead of the task itself.

189. Although the IWS provides only a summary of the decommissioning strategy, we have reviewed Chapter 31 of the pre-construction safety report (PCSR) (Hitachi-GE, 2017g) where the details that implement the strategy are contained. We have also reviewed Hitachi-GE's radioactive waste management arrangements, which provide greater detail on how decommissioning wastes will be managed.

190. With ONR, we requested further information from Hitachi-GE on decommissioning to be considered in ONR's Step 4 assessment (RQ-ABWR-0825, RQ-ABWR-0826 RQ-ABWR-0827 and RQ-ABWR-0833). We requested that Hitachi-GE provide further detailed evidence on decommissioning in GDA to demonstrate that the UK ABWR design has been optimised for decommissioning. We note that this would also help any future operator in providing a decommissioning and waste management plan.

191. A workshop was held with ONR and Hitachi-GE in July 2016 to discuss progress in this area and Hitachi-GE provided supporting evidence in a series of topic reports (TR):

- TR 1: Decommissioning strategy
- TR 2: Design for decommissioning
- TR 3: Decommissioning plan

- TR 4: Decommissioning techniques
- TR 5: Impact of construction techniques on decommissioning
- TR 6: Decommissioning waste management
- TR 7: Decommissioning safety assessment

192. At the time of writing our consultation documents we had not received all documentation associated with Hitachi-GE's decommissioning case, we, therefore, could not assess if the UK ABWR had been designed to facilitate decommissioning. We included a potential GDA Issue in our consultation: '*Potential GDA Issue 1 – Decommissioning of the UK ABWR. We require Hitachi-GE to provide sufficient evidence to demonstrate that the UK ABWR has been designed to facilitate decommissioning and hence to minimise associated waste and impacts on people and the environment from decommissioning operations.'*

193. We have received Hitachi-GE's full decommissioning case and assessed this, we have also engaged with Hitachi-GE through workshops and meetings, in collaboration with ONR, to raise RQs and discuss the decommissioning case.

194. In its submissions, Hitachi-GE has provided a decommissioning plan and strategy that specifies how the UK ABWR could be decommissioned. In addition, Hitachi-GE has specified examples of how the design has been challenged and optimised to facilitate decommissioning. Hitachi-GE has provided details of expected waste arisings associated with decommissioning activities and how these could be minimised, for example by using low impurity construction materials and applying decontamination techniques.

195. We have concluded that the UK ABWR design facilitates decommissioning, and uses BAT to minimise waste arising and impacts on people and the environment.

196. The Nuclear Reactors' (Environmental Impact Assessment for Decommissioning) Regulations 1999 (EIADR) (GB Parliament, 1999) and Amendment (GB Parliament, 2006) cover the environmental impact of decommissioning on habitats. The ONR is responsible for ensuring the requirements of EIADR are followed.

Our overall conclusions on strategic considerations for radioactive waste management

197. Hitachi-GE's IWS is adequate for the purposes of generic design assessment.

198. Hitachi-GE's IWS defines how the waste hierarchy should be applied to wastes generated at all stages of the UK ABWR's life, from construction to operation and decommissioning.

199. The IWS appropriately considers at a strategic level how all radioactive and non-radioactive waste streams will be managed.

200. The IWS does not identify any waste streams for which there is:

- currently no disposal route, and
- no future disposal route identified

201. We have identified 2 Assessment Findings, as set out at the beginning of this chapter.

More details of our assessment of strategic considerations are provided in our report [AR02 - Assessment of the strategic approach to waste management] (Environment Agency, 2017b).

7. Process for identifying best available techniques

This chapter covers our assessment of Hitachi-GE's process for identifying best available techniques (BAT). Identifying BAT involves balancing the benefits of minimising the amount of radioactive waste generated and discharged against the costs involved, including non-monetary costs such as any increase in worker dose or reduction in nuclear safety. The results lead to a design that is capable of meeting high environmental standards but where the financial cost of applying techniques is not grossly disproportionate in relation to the environmental protection they provide.

We conclude that Hitachi-GE has followed an appropriate process for identifying BAT.

Please read below for a summary of our detailed assessment and links to further supporting documents.

About BAT

202. There is a requirement under the Environmental Permitting Regulations 2016 (EPR16) that we exercise our functions to ensure that all exposures to ionising radiation of any member of the public and of the population as a whole resulting from the disposal of radioactive wastes are kept as low as reasonably achievable (ALARA), taking into account economic and social factors. This principle and legal requirement originates in the EU Basic Safety Standards Directive (Council Directive 96/29/Euratom) (EU, 1996) and is also a requirement of the Oslo and Paris Commission (OSPAR, 1992). We do this by requiring designers and operators to use BAT to:

- prevent and minimise the creation of radioactive waste
- minimise the discharges of gaseous and aqueous radioactive waste to the environment
- minimise the impact of those discharges on people, and adequately protect other species

The use of BAT to prevent and eliminate pollution, including radioactive and nonradioactive substances and energy capable of causing harm, is also a requirement of the Oslo and Paris Commission (OSPAR, 1992)

Definition of BAT

Best available techniques means the latest stage of development (state of the art) of processes, of facilities or of methods of operation, which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste. In determining whether a set of processes, facilities and methods of operation constitute the best available techniques in general or individual cases, special consideration shall be given to:

- comparable processes, facilities or methods of operation that have recently been successfully tried out
- technological advances and changes in scientific knowledge and understanding

- the economic feasibility of such techniques
- time limits for installation in both new and existing plant
- the nature and volume of the discharges and emissions concerned

Techniques include both the technology used and the way in which the installation is designed, built, maintained, operated and dismantled.

(OSPAR, 1992)

203. BAT is, therefore, a fundamental aspect of radioactive substances regulation, and we expect it to be identified by an appropriate process as described in our REPs (Environment Agency, 2010) at principle RSMDP4 (methodology for identifying BAT). We refer to BAT as the means an operator of a facility uses to deliver an 'optimised' outcome, to reduce exposures to ALARA. Optimisation requires the operator to make judgements about the relative significance of various issues, including:

- the number of people (workers and the public) and other environmental targets that may be exposed to radiological risk
- the likelihood that they could be exposed to radiation, where exposure is not certain to happen
- the magnitude and distribution in time and space of radiation doses that they will or could receive
- nuclear security and safeguards requirements
- issues similar to those above, but relating to non-radiological hazards
- economic, societal and environmental factors
- technical viability
- uncertainties in any of the above

Guidance on optimisation can be found in our 'priniciples of optimisation in the management and disposal of radioactive waste' document.

Hitachi-GE's process for identifying BAT

204. We consider Hitachi-GE's approach to optimisation to be a suitable basis from which to identify BAT for the UK ABWR for GDA purposes. The approach is documented in a dedicated Hitachi-GE 'Approach to optimisation' submission. Claims generated as part of this optimisation process are presented along with their accompanying arguments and evidence in the 'Demonstration of BAT' submission. These submissions are listed in Appendix 3.

205. Hitachi-GE has suitably recognised the relevant principles of optimisation and sought to apply these in presenting the GDA case. It has also considered standard environmental permit conditions and our P&ID requirements (Environment Agency, 2016b) relating to optimisation.

206. Hitachi-GE has also carried out a number of engineering option selection (referred to as optioneering) exercises to optimise the design of the UK ABWR for GDA purposes. Minimising the amount of radioactive waste generated and discharged has been one factor in these exercises. Overall, we conclude that Hitachi-GE has used optioneering approaches where appropriate, targeting those aspects that are relevant to the UK design and, where prompted, in response to specific regulatory considerations, for example, to justify specific design configurations.

207. Hitachi-GE's approach has been to set out claims, develop arguments in support of these, and to provide the relevant underpinning evidence, where possible. Hitachi-GE provides a specific radionuclide route map in its 'Demonstration of BAT' submission, which indicates how the

developed BAT arguments apply to specific radionuclides and, in particular, those that are significant constituents of gaseous and aqueous discharges or solid waste.

208. The approach recognises that the UK ABWR is an evolution of earlier BWR technology and reflects on design improvements that are relevant to the BAT claims. We consider this to be a sensible approach and a suitable method by which to convey the 'BAT case' for GDA of the UK ABWR.

209. Hitachi-GE has provided extensive evidence. This is reflected in more than 100 references that support the 'Demonstration of BAT' submission. A large number of Regulatory Queries in relation to BAT aspects have been raised, often jointly with ONR. Hitachi-GE has responded to the Regulatory Queries and, in many cases, the response has subsequently become a supporting reference.

210. Hitachi-GE's approach has also included identifying aspects relating to BAT that any future operators will need to consider (for example, at the detailed design and permitting stage). These aspects have been identified as 'forward actions'. We consider this to be a useful approach and recognise the value of these actions.

211. Overall, we conclude that, in principle, Hitachi-GE has followed an appropriate process for identifying BAT in the design of the UK ABWR. However, demonstrating that BAT has been applied to the design and operation of the UK ABWR requires balancing of relevant factors, including safety aspects. Therefore, optimisation must be based on an overall approach that considers both BAT and 'as low as reasonably practicable' or ALARP (the equivalent approach for the safety case), where appropriate.

212. ONR raised a number of Regulatory Observations ultimately relating to ALARP considerations for plant systems where BAT is also relevant (for example, the radioactive waste management systems). Of particular relevance are: RO-ABWR-0036, 'Demonstration that the approach taken to radioactive waste management reduces risks so far as is reasonably practicable (SFAIRP)', and RO-ABWR-0054, 'UK ABWR – Chemical/process engineering design approach'.

These ROs are now closed and the resolution of these ROs has not resulted in any significant impact on the claims, arguments and evidence that Hitachi-GE has made in its 'Demonstration of BAT' submission. This has resulted in the removal of the potential GDA Issue included in our consultation document that related to the BAT and ALARP cases not being fuilly aligned. However, we note that there is an ONR Assessment Finding (AF-ABWR-RW-2) requiring further ALARP justification for the HCW system. This does not impact on the BAT case for GDA, but may require some re-evaluation for site-specific assessment.

213. We have concluded that BAT is adequately addressed in Hitachi-GE's design development processes.

More details of our assessment of BAT to prevent and minimise the creation of radioactive waste are provided in our report on the assessment of BAT [AR03 - Assessment of best available techniques] (Environment Agency, 2017c).

8. Preventing and minimising the creation of radioactive waste

This chapter covers our assessment of Hitachi-GE's techniques used to prevent and minimise the creation of radioactive waste. We have assessed Hitachi-GE's submission with respect to the:

- sources of radioactivity in the reactor that will eventually become waste, and the techniques used to minimise the amount produced
- containment of radioactive substances in the plant, since losses can result in large volumes of radioactive waste and contamination of land or groundwater
- processing of radioactive substances in the plant and how this affects the distribution of radioactivity between gaseous, aqueous and solid waste streams

We conclude that the UK ABWR uses BAT to:

- prevent and minimise the creation of radioactive waste
- support the principle of 'concentrate and contain'
- minimise the overall impact of discharges to the environment

We have identified 4 Assessment Findings:

- **Assessment Finding 3**: A future operator shall demonstrate that the UK ABWR will be operated in a manner that represents best available techniques, addressing in particular:
    - fuel selection
    - fuel and core management
    - avoidance of control rod failure in power suppression situations
    - consideration of all normal operational modes and stages of the reactor's life cycle
    - control of water chemistry
    - selection of demineraliser resins for liquid waste management systems
- **Assessment Finding 4**: A future operator shall review the practicability of techniques for abatement of carbon-14 prior to operation.
- **Assessment Finding 5**: A future operator shall assess the partitioning of carbon-14 between gaseous, aqueous and solid waste streams, during initial operations.
- **Assessment Finding 6**: A future operator shall address the 15 forward actions as identified by Hitachi-GE in the 'Demonstration of best available techniques' submission - GA91-9901-0023-00001 Revision G (August 2017), (Hitachi-GE, 2017a).

Table 8.1 - Summary of Hitachi-GE's forward actions for a future operator (Assessment Finding 6)

Follow-up actions for a future operator identified by Hitachi-GE
To support the demonstration that performance of systems deemed to be BAT are as expected and have, therefore, been optimised.

An assessment shall be undertaken to determine BAT for the selection of demineraliser resins.
Undertake a BAT assessment of carbon-14 abatement techniques using alkaline scrubbing.
Commissioning data shall be provided to support the design basis calculations currently being used to substantiate the argument that the delay period provided by the off-gas delay beds represents BAT.
Undertake a BAT assessment of waste management techniques post-GDA taking into account site-specific factors including the proximity principle.
Undertake a BAT assessment to support the specification and selection of equipment to be used in the radioactive waste management building.
Undertake a BAT assessment of waste management routes taking into account site-specific factors including the proximity principle and other relevant factors to fully substantiate 'Argument 4b'.
The management of waste, the final waste route and the quantity of waste to be consigned will be determined through the application of BAT by a future operator.
A future operator shall select the techniques for environmental sampling and determine the environmental monitoring programme.
A future operator shall assess the cobalt content of steels based on availability and cost from available suppliers.
A future operator shall demonstrate BAT when selecting its plans for packaging, storage and disposal of spent fuel.
A future operator shall determine the optimal stack height.
A future operator shall determine the management and arrangements for aqueous discharges.
A future operator shall assess and define the decay storage timescales.
Management arrangements will be developed to ensure that BAT is considered through the life cycle of the project, from design to decommissioning.

Please read below for a summary of our detailed assessment and links to further supporting documents.

Sources and minimisation of radioactivity

214. This section describes the sources of radioactive materials in the UK ABWR that will eventually become waste, and the techniques used to minimise the amount of waste produced.

215. Hitachi-GE provides a diagram of the sources and routings of radioactive wastes within the UK ABWR in Figure 8.1. A summary of the main aspects for the most significant radionuclides contributing to discharges from the UK ABWR design is provided in Tables 8.2 and 8.3. A summary of the projected annual discharges is also provided in Hitach-GE's 'Quantification of discharges and limits' submission. Chapter 11 provides a summary of the solid radioactive waste arisings from the UK ABWR design.

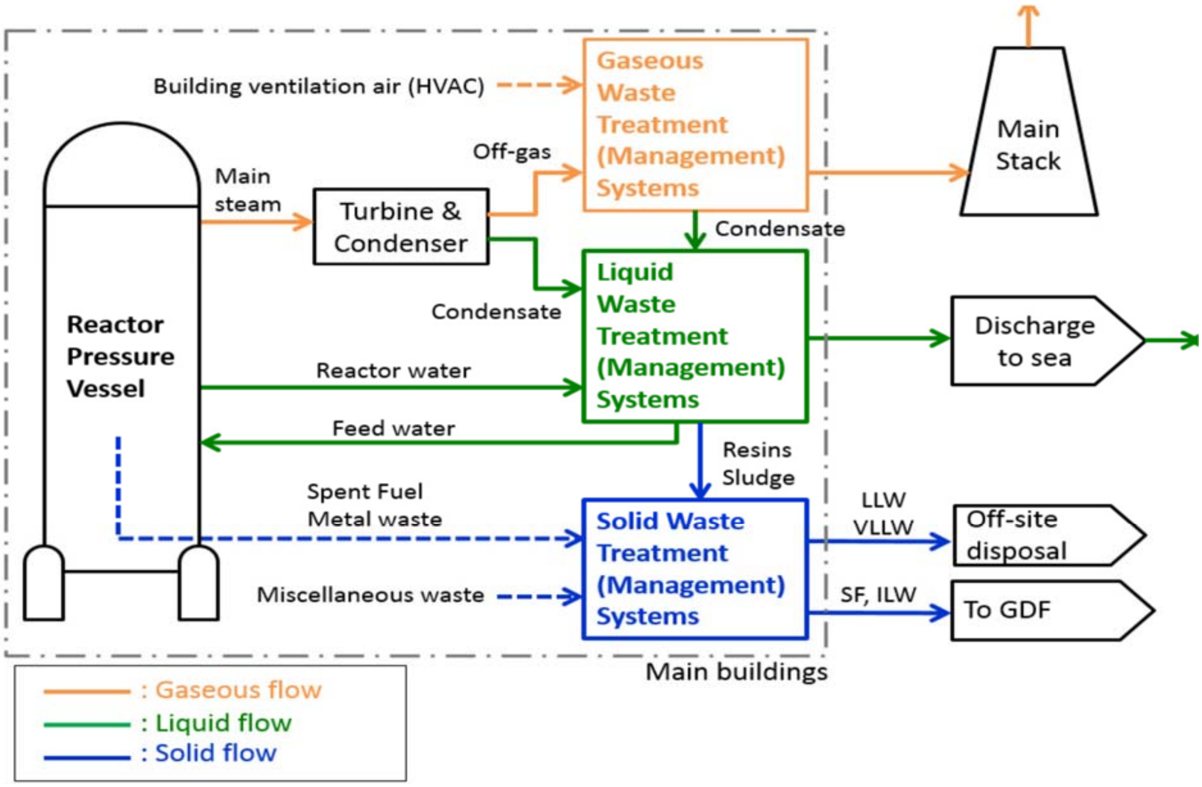

Figure 8.1: Diagram of gaseous, liquid and solid waste arisings within the UK ABWR (from Hitachi-GE's Summary of the Generic Environmental Permit Applications GA91-9901-0019-00001 Revision H).

216. The origins of radioactivity within the UK ABWR are mainly:

(a) Activation of chemical species in the primary reactor coolant (water). Important radionuclides arising in this way are argon-41 and carbon-14, which transfer to the gaseous discharge stream. Other notable activation products include tritium (H-3) and cobalt-60.

(b) Fission products formed in the fuel. These may leak into the primary coolant through any defects in the fuel cladding. Soluble fission products that form ionic species are predominantly accumulated on ion exchange resins and filters and, therefore, arise ultimately as solid waste for disposal. There are very limited liquid discharges from the UK ABWR. Noble gases, including radionuclides of krypton, xenon and argon, are extensively retained on delay beds. Spent fuel is assumed to be waste for GDA purposes and this will contain the majority of radioactivity.

217. Activated and contaminated metals within the plant become solid waste for disposal. Corrosion products from the metal components of the reactor system are also a significant source of waste arisings. Corrosion products entrained within the reactor coolant are activated as they pass through the core of the reactor. In radioactivity terms, the most significant radionuclide arising in this way is cobalt-60. Corrosion products tend to accumulate on filters and ion exchange media within the liquid system and are largely associated with solid wastes for eventual disposal.

218. Tritium (H-3) arises via a number of mechanisms, including ternary fission in fuel, neutron reactions of boron-10 (a component of some control rods) and from activation of deuterium (H-2).

219. Based on the extensive documentation Hitachi-GE provided we conclude that, at this stage, Hitachi-GE has broadly identified the radionuclides that will contribute significantly to the amount of activity in waste disposals and will result in doses to members of the public. However, sources of radioactivity in the UK ABWR design were subject to a joint Environment Agency/ONR Regulatory

Observation (RO-ABWR-0006) and a subsequent Regulatory Issue (RI-ABWR-0001), 'Definition and Justification for the Radioactive Source Terms in UK ABWR during Normal Operations'.

220. The Environment Agency and ONR raised RO-ABWR-0006 on 28 April 2014. Two of the actions under the RO requested the radiological source terms for the UK ABWR design to be defined and justified. This was raised because Hitachi-GE's GDA submission lacked information regarding radionuclides in the UK ABWR during normal operation. The submission also lacked evidence to support the gaseous and aqueous discharge estimates and proposed limits. We received a resolution plan for this RO on 15 July 2014 and we had regular meetings with Hitachi-GE between July and December 2014. Hitachi-GE submitted 2 reports to us in January 2015, which we and ONR assessed. These reports were intended to address the definition and justification of source terms for the UK ABWR. However, these reports did not meet our expectations, and together with ONR, we provided feedback to Hitachi-GE outlining shortfalls in the reports. We challenged the approach and methodology used to derive the UK ABWR source terms, the limited use of operational experience (OPEX) data from other operating ABWRs and the evidence on which discharge estimates were based.

221. Together with ONR, we escalated the RO to an RI. A workshop was held on 19, 20 and 22 May 2015 at which, we and ONR presented our requirements to Hitachi-GE and gave some examples of source terms that we have assessed for other nuclear power plant designers and operators. RI-ABWR-0001 was raised on 3 June 2015. Regular meetings were held between regulators and Hitachi-GE and have been ongoing since June 2015. Hitachi-GE has changed its approach to deriving and justifying source terms for the UK ABWR, using more OPEX data and providing more explanation of the methods used. Between November 2015 and February 2016 we received a number of reports documenting how it had derived and justified the UK ABWR source term. These provided information on the primary source term (radionuclides in the reactor water and steam), process source terms (radionuclides in different downstream systems within the plant) and end-user source terms (which included source term for gaseous and aqueous discharges).

222. Both RI-ABWR-0001 and RO-ABWR-0006 are now closed to the regulators' satisfaction.

223. From the source term work Hitachi-GE has identified the major radionuclides in gaseous and aqueous discharges. Their sources and minimisation techniques are summarised in the tables below.

Table 8.2 – Major radionuclides in gaseous discharges, approaches and techniques to minimise quantities and impacts

Radionuclide	Sources	Approach and techniques to minimise quantities and impacts
Argon-41	Activation of entrained atmospheric Ar-40 in coolant	Minimisation of leaks (Argument 1j) and the air leakage into the main condenser. Off-gas treatment system charcoal delay beds (Argument 2a and 2b). Discharge at height via main stack (Argument 5a).
Other noble gases	Fission products (FP) from fuel and structural uranium. Radioactive noble gases are formed by fission.	Minimise fuel-cladding failures (grid-to-rod fretting, corrosion and crud, debris, pellet cladding interaction (PCI)) and manufacturing quality assurance (QA) (Argument 1a).

Radionuclide	Sources	Approach and techniques to minimise quantities and impacts
	They are usually confined within the fuel but in the event of fuel leaks, they can pass into the coolant via defects in the fuel cladding. Their presence in the coolant is also due to the occurrence of traces of uranium ('tramp' uranium[2]) on the surface of fuel assemblies following the manufacturing process.	High standards of fuel design and fabrication (Argument 1a). Minimise 'tramp uranium' (Argument 1a). Minimise crud formation and optimal water chemistry (Argument 1f). An efficient anti debris device is provided for fuel assemblies (Argument 1a). The fuel performance - minimising the number of fuel assemblies used minimises the probability for cladding leakage of FPs into the coolant (Argument 1c). Identifying and isolating fuel leaks (Argument 1d). Minimise leaks (Argument 1j). Off-gas treatment system and charcoal delay beds (Argument 2a and 2b). Discharge at height via main stack (Argument 5a).
Iodine-131	FPs from fuel, structural uranium. Iodine isotopes are formed in the fuel by fission and can escape into the reactor coolant water via fuel defects. Also, like other FPs, small quantities are produced from uranium contamination on fuel surface ('tramp' uranium) within the reactor which can also be found in the coolant.	Migration into reactor water (direct or through pin fracture) → Partial migration into steam → Separation at condenser → Discharge via stack via off-gas system (OG) (negligible). Discharge of volatile iodine in aqueous stream via heating, ventilating and air-conditioning system (HVAC). Minimise fuel cladding failures (grid-to-rod fretting, corrosion and crud, debris, PCI, and manufacturing upsets) (Argument 1a). High standards of fuel design and fabrication (Argument 1a). Minimise 'tramp uranium' (Argument 1a). Minimise crud formation and optimal water chemistry (Argument 1f). An efficient anti debris device is implemented for fuel assemblies (Argument 1a). The fuel performance - minimising the number of fuel assemblies used minimises

[2] 'tramp uranium' is any uranium on the external surfaces of the fuel. This has the potential to undergo nuclear fission and to generate fission products that will enter the steam circuit.

Radionuclide	Sources	Approach and techniques to minimise quantities and impacts
		the probability for cladding leakage of FPs into the coolant (Argument 1c). Identifying and isolating fuel leaks (Argument 1d). Minimise leaks (Argument 1j).
Strontium-90 **Strontium-89**	FPs from fuel, structural uranium. Isotopes of strontium are formed as a result of fission. They are usually confined in the fuel but, in the event of fuel leaks, they can pass into the coolant via defects in the fuel cladding. Their presence in the coolant is also due to the occurrence of traces of uranium ('tramp' uranium) on new fuel assemblies following the manufacturing process.	Minimise fuel cladding failures (grid-to-rod fretting, corrosion and crud, debris, PCI, and manufacturing upsets) (Argument 1a). High standards of fuel design and fabrication (Argument 1a). Minimise 'tramp uranium' (Argument 1a). Minimisation of crud formation and optimal water chemistry (Argument 1f). An efficient anti debris device is implemented for fuel assemblies (Argument 1a). The fuel performance - minimising the number of fuel assemblies used minimises the probability for cladding leakage of FPs into the coolant (Argument 1c). Identifying and isolating fuel leaks (Argument 1d). Minimise leaks (Argument 1j). Filters to remove particulate material (Argument 2d). Discharge at height via main stack (Argument 5a).
Caesium-137	FPs from fuel, structural uranium.	As for strontium-89 and strontium-90.
Cobalt-60	Cobalt-60 formed from cobalt-59 Activation of reactor components. Activation of insoluble and soluble metal crud and particulate in reactor water.	Minimise crud formation and optimal water chemistry (Argument 1f). Specification of low cobalt content materials (Argument 1g). Minimise leaks (Argument 1j). Filters to remove particulate material (including filters on the HVAC) (Argument 2d). Discharge at height via main stack (Argument 5a).
Tritium	Ternary fission in fuel.	No boron usage in the water chemistry (Argument 1b).

Radionuclide	Sources	Approach and techniques to minimise quantities and impacts
	Tritium from boron-10 in control rods.	Use of hafnium control rods (Argument 1b). Use of gadolinium as a burnable poison rather than boron (Argument 1b).
	Hydrogen-3 produced from hydrogen-2 in reactor water.	Minimise fuel cladding failures (grid-to-rod fretting, corrosion and crud, debris, PCI, and manufacturing upsets) (Argument 1a). High standards of fuel design and fabrication (Argument 1a). Minimise crud formation and optimal water chemistry (Argument 1f). An efficient anti debris device is implemented for fuel assemblies (Argument 1a). The fuel performance - minimising the number of fuel assemblies used minimises the probability for cladding leakage of FPs into the coolant (Argument 1c). Identifying and isolating fuel leaks (Argument 1d). Minimise leaks (Argument 1j). Gaseous tritium present within the off-gas is removed by the off-gas recombiner and off-gas condenser. The off-gas recombiner recombines hydrogen and oxygen and the off-gas condenser cools and condenses the hydrogen depleted off-gas to separate any moisture and return it to the main condenser. Following treatment by these 2 components of the off-gas system the hydrogen concentration is minimised in the off-gas. As tritium is a hydrogen compound, the performance of the off-gas recombiner and off-gas condenser, therefore, also removes tritium from the off-gas. The hydrogen and, therefore, any tritium is converted to water and is returned to the condensate storage tank (CST) where it is reused within the plant. (Argument 2a). Discharge at height via main stack (Argument 5a).
Carbon-14	Neutron activation of nitrogen-14 and oxygen-17 results in carbon-14 both from fuel and reactor water.	None. The main source of carbon-14 is the thermal neutron reaction with oxygen-17 in the reactor coolant water (H_2O). Therefore,

Radionuclide	Sources	Approach and techniques to minimise quantities and impacts
	In another minor mechanism contributing to carbon-14, carbon-13 produces carbon-14, in the presence of dissolved carbon in the coolant.	there are no measures for reducing the generation.

Note – please see assessment report AR03 - Assessment of best available techniques (Environment Agency, 2017c) for 'arguments' referred to in Table 8.2.

Table 8.3 – Major radionuclides in aqueous discharges, approaches and techniques to minimise quantities and impacts

Radionuclide	Sources and amounts	Approach and techniques to minimise quantities and impacts
Strontium-90 **Strontium-89**	FPs from fuel, structural uranium. Isotopes of strontium are formed as a result of fission. They are usually confined in the fuel but, in the event of fuel leaks, they can pass into the coolant via defects in the fuel cladding. Their presence in the coolant is also due to the occurrence of traces of uranium ('tramp' uranium) that can never be completely removed on new fuel assemblies following the manufacturing process.	Minimise fuel cladding failures (grid-to-rod fretting, corrosion and crud, debris, PCI, and manufacturing upsets) (Argument 1a). High standards of fuel design and fabrication (Argument 1a). Minimise 'tramp uranium' (Argument 1a). Minimise crud formation and optimal water chemistry (Argument 1f). An efficient anti debris device is implemented for fuel assemblies (Argument 1a). The fuel performance - minimising the number of fuel assemblies used minimises the probability for cladding leakage of FPs into the coolant (Argument 1c). Identifying and isolating fuel leaks (Argument 1d). Minimise leaks (Argument 1j). Reactor water clean-up system (CUW) (Argument 1h). Laundry drain (LD) pre-filter. LD activated carbon adsorption tower activated charcoal. LD filter. High chemical impurities waste (HCW) evaporator. HCW demineraliser. (Argument 2e, Argument 2g and 2h).

Radionuclide	Sources and amounts	Approach and techniques to minimise quantities and impacts
Iodine-131	FPs from fuel, structural uranium. Iodine isotopes are formed in the fuel by fission and can escape into the reactor coolant water via fuel defects. Also, like other FPs, small quantities are produced from uranium contamination on fuel surface ('tramp' uranium) within the reactor, which can also be found in the coolant.	As for strontium-89 and strontium-90.
Caesium-137	FPs from fuel, structural uranium.	As for strontium-89 and strontium-90.
Cobalt-60	Cobalt-60 produced from cobalt-59. Activation of reactor components. Activation of insoluble and soluble metal crud and particulate in reactor water.	Minimise crud formation and optimal water chemistry (Argument 1f). Specification of low cobalt content materials (Argument 1g). Minimise leaks (Argument 1j). CUW system (Argument 1h). LD pre-filter. LD filter. LD activated carbon adsorption tower. HCW evaporator. HCW demineraliser. (Arguments 2e, 2g and 2h).
Tritium	Ternary fission in fuel Tritium produced from boron-10 in control rods. Hydrogen-3 produced from hydrogen-2 in reactor water.	No boron usage in the water chemistry (Argument 1b). Use of hafnium control rods (Argument 1b). Use of gadolinium as a burnable poison rather than boron (Argument 1b). Minimise fuel cladding failures (grid-to-rod fretting, corrosion and crud, debris, PCI and manufacturing upsets) (Argument 1a). High standards of fuel design and fabrication (Argument 1a). Minimise crud formation and optimal water chemistry (Argument 1f).

Radionuclide	Sources and amounts	Approach and techniques to minimise quantities and impacts
		An efficient anti debris device is implemented for fuel assemblies (Argument 1a). The fuel performance - minimising the number of fuel elements used minimises the probability for cladding leakage of FPs into the coolant (Argument 1c). Identifying and isolating fuel leaks (Argument 1d). Minimise leaks (Argument 1j). No abatement (Argument 2e)

Note – please see assessment report AR03 - Assessment of best available techniques (Environment Agency, 2017c) for 'arguments' referred to in Table 8.3.

224. Hitachi-GE claims that the UK ABWR design eliminates or reduces the generation of radioactive waste. It provides claims, arguments and evidence in support of this as part of its 'Demonstration of BAT' submission. The arguments Hitachi-GE presents and our associated conclusions are provided in Assessment Report AR03 - Assessment of best available techniques (Environment Agency, 2017c). The developed BAT arguments can be applied to specific radionuclides and, in particular, those that are major consistuents of gaseous and liquid discharges (Tables 8.2 and 8.3 above).

225. We broadly agree with these claims and arguments based on our sampling of the evidence as presented. However, we note that there are operator choices to be considered in the future that may impact on BAT. Therefore, we have included an Assessment Finding (Assessment Finding 3) to ensure that operator choices also reflect BAT and are appropriately optimised for both environment and safety.

- **Assessment Finding 3**: A future operator shall demonstrate that the UK ABWR will be operated in a manner that represents best available techniques, addressing in particular:
    - fuel selection
    - fuel and core management
    - avoidance of control rod failure in power suppression situations
    - consideration of all normal operational modes and stages of the reactor's life cycle
    - control of water chemistry
    - selection of demineraliser resins for liquid waste management systems

226. The UK ABWR design contains a range of features that contribute to eliminating or reducing waste arisings. Hitachi-GE has identified the most significant of these, as follows:

- the design, manufacture and management of nuclear fuel to minimise the potential for a release of fission products (FP) from the fuel into the steam circuit or cooling pool water
- eliminating or reducing materials that are susceptible to activation at all stages of commissioning and operation
- reducing the amount of spent fuel (SF) and higher activity waste (HAW) generated for a given energy output
- reducing the amount of lower activity waste generated for a given energy output

- promptly detecting and managing failed fuel
- introducing techniques to be used during commissioning, start-up and shutdown

227. The UK ABWR design also includes features to minimise the radioactivity in radioactive waste disposed to the environment. Hitachi-GE identifies the most significant of these, as follows:

- providing an off-gas system (OG) that includes processes to reduce radioactivity in the gaseous phase prior to discharge to the environment
- providing off-gas charcoal adsorber within the OG to abate short lived FPs
- providing a heating, ventilating and air conditioning system (HVAC) that prevents the uncontrolled discharge of radioactive substances
- treatment techniques for aqueous wastes that minimise the discharge of radioactivity to the environment
- decay storage to minimise the radioactivity associated with wastes that require disposal

228. The UK ABWR design also includes features to minimise the volume of radioactive waste disposed of to other premises. Hitachi-GE identifies the most significant of these, as follows:

- design changes that will minimise the volumes of operational and decommissioning waste arisings
- providing a number of features that will allow future operators to adopt an operating philosophy that will minimise the quantity of solid radioactive waste associated with routine operations and maintenance
- providing dedicated facilities for managing, treating and storing solid radioactive waste
- reducing the quantity of solidified high chemical impurity wastes (HCW) that are generated
- availability of a range of decontamination techniques during decommissioning

229. We conclude that Hitachi-GE has adequately demonstrated that the UK ABWR design will minimise the amount of of radioactive waste produced. We have identified a number of aspects that we expect any future operators to pursue, please see Assessment Finding 3 and our assessment report (AR03) for further details.

Containment of radioactive substances

230. Any radioactivity formed in the reactor and not retained in the fuel will inevitably end up as radioactive waste. However, the volume of waste produced can be minimised by containing the radioactivity within those parts of the plant where it is intended to be, and not allowing it to contaminate other parts of the plant, land, air or groundwater.

231. Hitachi-GE has provided a number of claims, arguments and evidence in support of the containment features of the UK ABWR design. We note the following arguments, presented in Hitachi-GE's 'Demonstration of BAT' submission, as being particularly relevant in this regard:

- Argument 1a: Design, manufacture and management of fuel
- Argument 1d: Detection and management of failed fuel
- Argument 1h: Recycling water to prevent discharges
- Argument 1j: Leak tightness of liquid, gas and mixed phase systems
- Argument 2b: Delay beds for noble gases and iodine
- Argument 2c: Heating, ventilation and air conditioning system
- Argument 2d: Filtration of airborne particulate matter
- Argument 2f: Configuration of liquid management systems
- Argument 2g: Sizing of tanks, vessels and liquid containment systems
- Argument 2h: Demineralisers for distillates from the high chemical impurities waste evaporator

- Argument 2i: Evaporation of high chemical impurities waste
- Argument 2j: Radioactive decay of solid and liquid wastes

232. We provide our views on each of these arguments in assessment report AR03 - Assessment of best available techniques (Environment Agency, 2017c).

233. We have concluded that the design of the UK ABWR is suitable to ensure containment of radioactive substances.

Processing radioactive substances in the UK ABWR

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

235. Hitachi-GE has described how radioactive substances will be processed in the UK ABWR to ensure that waste is appropriately managed for disposal. Below, we summarise the design features of the UK ABWR that apply to the processing of gaseous, aqueous, other liquid and solid wastes.

Processing gaseous wastes

236. In broad terms, the UK ABWR design aims to avoid and reduce gaseous waste arisings, limit the concentration of radionuclides in gaseous wastes by using delay beds, and to remove particulate material from gaseous wastes using high-efficiency particulate air (HEPA) filtration.

237. The 'off-gas radioactive waste treatment system' has 2 main functions:

(i) to safely recombine flammable gases (hydrogen and oxygen), which are generated by radioactive decomposition of reactor cooling water

(ii) to minimise and control the release of small quantities of slightly radioactive gases into the atmosphere by delaying and filtering the OG waste process stream to adequately decay short-lived radioactive isotopes and filter out particulate matter, therefore keeping releases within discharge limits

238. The main features of the design relevant to minimising the impact of gaseous discharges are as follows:

- the design, manufacture and management of nuclear fuel to minimise the potential for a release of fission products (FP) from the fuel into the steam circuit or cooling pool water
- promptly detecting and managing failed fuel
- providing an off-gas system (OG) that includes processes to reduce radioactivity in the gaseous phase prior to discharge to the environment
- providing an off-gas charcoal adsorber within the OG to abate short lived FPs
- providing a heating, ventilating and air conditioning system (HVAC) that prevents the uncontrolled discharge of radioactive substances

239. Moisture in the gas stream is first condensed, and then the remaining non-condensable gases (principally air with a small amount of radioactive argon, krypton and xenon gas) are extracted and passed through OG charcoal adsorber beds. These adsorbers provide adequate ‘hold-up’ or ‘delay’ to allow time for the radioactive gases to decay to lower activity levels before leaving the system.

240. After this processing step, the treated gaseous waste is monitored and released to the environment through the main stack.

241. The HVAC is identified as 'building ventilation air' in Figure 8.1. The functions of the HVAC relevant to managing gaseous radioactive wastes are to limit and contain the possible release of radioactive materials from plant and equipment in an area during normal operation, maintenance or inspection, and, where necessary, filter contaminated air prior to its discharge to atmosphere.

242. The buildings that can potentially generate gaseous radioactive wastes, because of the inventories within them, are the reactor building, the turbine building and the radioactive waste building. Radiologically-controlled area HVACs will include high-efficiency particulate air (HEPA) filters on their discharge. Where practicable, and where required to provide adequate dispersion, the HVACs will discharge to the environment via the main stack. The HVAC discharge from the main stack also includes the tank vents and extracts from the various tanks in the radioactive waste building that join the radioactive waste building HVAC.

243. We observe the following:

- Using a modern fuel design and further measures to reduce fuel failure rates will help minimise gaseous waste arisings by limiting releases from fuel failure. Measures to detect and manage fuel failure should also prove effective. The regulators will seek to ensure that any future operators develop suitable arrangements to minimise gaseous discharges through appropriate fuel management.
- Using delay bed technology is effective at reducing discharges of noble gases, consistent with the application of BAT for such gases and consistent with approaches adopted in other light water reactors. Delay beds are also effective at reducing the concentration of short-lived iodine radionuclides. We conclude that Hitachi-GE has demonstrated that the quantity of charcoal to enable delay has been optimised in the UK ABWR design.
- The UK ABWR design aims to discharge gases at height via a main stack and this will help to minimise the impacts of those discharges. The stack is located on top of the reactor building, with a height of 57 m.
- Hitachi-GE concludes that no abatement of tritium or carbon-14 is practicable at this time. We agree with Hitachi-GE. However, we have included an Assessment Finding (Assessment Finding 4) that a future operator should consider if abatement of carbon-14 from gaseous discharges is appropriate in a site-specific context. We expect an operator to review carbon-14 abatement and implement any abatement if it considered as BAT.
- **Assessment Finding 4**: A future operator shall review the practicability of techniques for abatement of carbon-14 prior to operation.

244. We conclude that, at this stage, the design of the UK ABWR is suitable for ensuring that BAT can be applied in minimising the impact of gaseous discharges.

245. We discuss gaseous discharges to the environment further in Chapter 9.

Processing aqueous wastes

246. The liquid radioactive waste management system (LWMS) is designed to control, collect, process, handle, store, and dispose of radioactive waste water generated during operation of the UK ABWR reactor and turbine. All potentially radioactive waste waters are collected in sumps or drain tanks at various locations in the plant and transferred to collection tanks within the radioactive waste building.

247. The LWMS has been designed to recycle as much of the treated waste water back into the reactor cooling water system as possible. An exception is waste water that contains detergent and organic impurities (from the laundry and showers), which is chemically incompatible with the reactor and fuel pool water systems.

248. The LWMS is divided into several sub-systems: the high chemical impurities waste (HCW), the low chemical impurities waste (LCW), laundry drain (LD) and controlled area drain (CAD). The sub-systems segregate waste water with differing characteristics (that is, type of impurity or chemical content), so that it can be treated appropriately and efficiently prior to re-use or eventual disposal. In a situation where the waste water from a treatment system is outside the limits for being re-used or disposed of, the waste water treatment systems can cycle the waste water back through the treatment systems until the relevant parameters or limits are met.

249. Despite the aim to re-use the waste water, there may be times when liquid discharges are necessary, when the on-site storage of treated liquid waste reaches full capacity. Hitachi-GE argues that the frequency, volume and contaminant loading of such liquid discharges are reduced to a very low level (and we consider this in Chapter 10). The LWMS normally operates on a batch basis. Provision is made for sampling and analysis at important process points and from the discharge tank to ensure that process parameters and discharge limits are met.

250. Detecting abnormal conditions through alarm systems as well as operational procedures protect against accidental discharges. Tanks, processing equipment, pumps, valves, and instruments that may contain radioactivity are arranged in appropriately shielded, access-controlled containments to minimise plant staff's exposure to radiation and to prevent or minimise radiation dose or release to the environment.

251. During operation, the LWMS will generate solid wastes that include those known as 'cruds or sludges', spent filters and spent ion exchange resins. The solid wastes will be treated and disposed of according to the solid radioactive waste management system (described below and in Chapter 11).

252. At decommissioning, the water within the reactor and fuel pool systems will be treated and discharged using the systems identified above as far as practicable. Redundant items of plant and equipment will be managed according to the solid radioactive waste management system.

253. We conclude that BAT is applied to aqueous radioactive discharges from the UK ABWR. At the current time, it is BAT not to abate tritium in aqueous discharges, noting that the dose impact from aqueous discharges from the UK ABWR is very small.

254. We note there is an assumption within the GDA source term that 100% of carbon-14 will partition to the gaseous waste stream. If this assumption is not valid, carbon-14 could enter the LWMS. We have, therefore, included an Assessment Finding (Assessment Finding 5) to ask that this assumption is validated. If the assumption is not valid, we would expect an operator to review the BAT case and potential environmental impacts.

- **Assessment Finding 5**: A future operator shall assess the partitioning of carbon-14 between gaseous, aqueous and solid waste streams, during initial operations.

255. We discuss aqueous discharges to the environment further in Chapter 10.

Processing solid wastes

256. Solid radioactive wastes are produced during the operational and decommissioning phases of a power station's life cycle. The UK ABWR design has a waste management strategy and system based on available treatment technologies and current and assumed future disposal facilities (see Chapter 6). The nature of the solid wastes that will arise in the UK ABWR is described further in Chapter 11.

257. A solid radioactive waste management system (SWMS) is designed to control, segregate, collect, handle, process, package and temporarily store wet and dry solid radioactive waste before being dispatched for off-site disposal. Hitachi-GE describes facilities capable of treating, interim and decay storing, where appropriate, and managing the disposal of solid radioactive wastes in accordance with the chosen options for managing these wastes, as described in Hitachi-GE's 'Radioactive waste management arrangements' submission.

Forward action plan

258. Hitachi-GE has identified further actions where operator choices could potentially impact on the GDA BAT case. We agree that this is appropriate and have included an Assessment Finding (Assessment Finding 6) to ensure that this forward action plan is implemented by a future operator.

- **Assessment Finding 6:** A future operator shall address the 15 forward actions as identified by Hitachi-GE in the 'Demonstration of best available techniques' submission - GA91-9901-0023-00001 Revision. G. August 2017 (Hitachi-GE, 2017a).

Our overall conclusions on preventing and minimising the creation of radioactive waste

259. We conclude that the UK ABWR uses BAT to:

- prevent and minimise the creation of radioactive waste
- support the principle of 'concentrate and contain'
- minimise the overall impact of discharges to the environment

260. We reach this conclusion, based on our assessment of the design and the supporting claims, arguments and evidence that Hitachi-GE has provided.

261. We have identified 4 Assessment Findings, as set out at the beginning of this chapter.

262. BAT aspects of sampling have been considered in Chapter 12.

263. More details of our assessment of BAT to prevent and minimise the creation of radioactive waste are provided in our report on the assessment of BAT [AR03 - Assessment of best available techniques] (Environment Agency, 2017c).

9. Gaseous discharges of radioactive waste

This chapter covers our assessment of the estimated radioactive gaseous discharges and proposed limits that the UK ABWR should be capable of demonstrating compliance with, and that we might include in any permit issued for a power station of this design.

We conclude that:

- **gaseous radioactive discharges arising from all modes of normal operation have been considered**
- **all appropriate radionuclides have been considered in deriving estimated gaseous discharges**
- **the derivation of estimated gaseous discharges is clear and supported by suitable evidence**
- **the selection of significant radionuclides is appropriate**
- **the proposed gaseous discharge limits are of an appropriate order**
- **the gaseous discharges from the UK ABWR will not exceed those of comparable power stations across the world and will be capable of meeting the limits set out below**

Radionuclide or group of radionuclides	Annual limit (Bq)
Argon-41 (Ar-41)	5.2E+12
Carbon-14 (C-14)	1.7E+12
Tritium (H-3)	1.0E+13
Noble gases (excluding Argon-41)	2.2E+11

Please read below for a summary of our detailed assessment and links to further supporting documents.

Sources of gaseous radioactive waste and proposed limits

264. This assessment considers the estimated discharges of gaseous radioactive waste and proposed gaseous discharge limits Hitachi-GE provided for its UK ABWR design.

265. Information on the sources of gaseous radioactive wastes, the quantification of arisings and discharges, and Hitachi-GE's proposed limits is provided in Hitachi-GE's 'Quantification of discharges and limits' submission.

266. Our assessment considered UK ABWR gaseous radioactive waste that is discharged to the environment via the main stack located on the reactor building. Gaseous discharges arising from all modes of normal operation have been considered. These include start-up, at power, shutdown and outage. Hitachi-GE has also considered discharges resulting from a fuel pin failure, which is reasonably forseeable during the lifetime of the reactor. We are satisfied that all aspects of normal operation have been considered.

267. We conclude that gaseous radioactive discharges arising from all modes of normal operation have been considered.

268. Hitachi-GE has not considered discharges to atmosphere from the service building, the solid LLW facility, the ILW store or the interim spent fuel store, which were defined as out of GDA scope by the requesting party. Details of these facilities are at the concept design stage and will not be finalised until site-specific permitting. This is an acceptable approach. Hitachi-GE states that the discharges from these facilities are expected to be a small fraction of the overall site discharges. A future operator will need to quantify discharges to atmosphere from these facilities.

269. Radionuclides are produced in the reactor core as:

- fission products produced from fission of tramp uranium or from leakage from fuel pin failure
- activated corrosion products produced from materials dissolved into the reactor water or particulates arising from wear and tear of the reactor
- activation products produced by neutron activation of water

Some radionuclides, which are not contained or abated within the plant, are discharged to the environment.

270. Gaseous discharges reach the main stack by 1 of 3 routes: via the off-gas system, via the heating, ventilating and air conditioning system (HVAC) or via the turbine gland steam system (TGS). The off-gas system (OG) contains 4 charcoal beds that delay noble gases and iodine radionuclides, allowing radioactive decay of radionuclides with short half-lives before they are discharged to the environment. Carbon-14 is also discharged via the OG. The HVAC contains high efficient particulate air (HEPA) filters that minimise the discharge of radioactive airborne particulates. Iodine radionuclides and tritium are also discharged via the stack from the HVAC and the TGS. There are currently no practicable methods of abating carbon-14 and tritium. All feeds enter the stack prior to the monitoring point.

271. Over 600 radionuclides were considered in deriving the source term for the UK ABWR. Those relevant to gaseous discharges were selected based on guidance from the European Commission (EU, 2004) and the Environment Agency (Environment Agency, 2012). We are satisfied that all relevant radionuclides that are likely to be discharged in gaseous form have been considered.

272. We conclude that all appropriate radionuclides have been considered in deriving estimated gaseous discharges.

273. Our guidance for GDA requires quantitative estimates of gaseous and aqueous radioactive wastes that are supported with performance data from similar facilities. The derivation of estimated discharges needs to be appropriate, clear and supported by evidence. Revision B of the generic environmental permit (GEP) submission (submitted by Hitachi-GE in March 2014) contained quantitative estimates of gaseous radioactive wastes, but lacked supporting performance data and explanation of how the discharge estimates had been derived. In April 2014, jointly with ONR, we raised a Regulatory Observation (RO-ABWR-0006) requiring Hitachi-GE to provide definition and justification of the radiological source terms for the UK ABWR design, including the source terms for gaseous and aqueous discharges, solid radioactive waste arisings, decommissioning and radiation protection. The RO also required Hitachi-GE to use the source term appropriately across the different technical areas for GDA, and to adequately capture the response to the RO in the GDA submission.

274. Documents on the definition and justification of source terms for UK ABWR Hitachi-GE provided in January 2015 did not meet our expectations. We challenged the approach and methodology used to derive the UK ABWR source terms, the limited use of operational experience (OPEX) data from other operating ABWRs and the evidence on which discharge estimates were based. As a result, the aspects of the RO concerned with definition and justification of source terms were escalated to a Regulatory Issue (RI-ABWR-0001). Between November 2015 and June 2016, Hitachi-GE provided a number of documents in response to RI-ABWR-0001. These documents met our

expectations and RI-ABWR-0001 was closed in October 2016. Following assessment of further submissions addressing the requirements of RO-ABWR-0006, this RO was closed in April 2017.

275. At the time that our consultation document was written, RI-ABWR-0001 and RO-ABWR-0006 remained open. Therefore, we identified a potential GDA Issue concerned with source terms. This was potential GDA Issue 2 requiring Hitachi-GE to provide a suitable and sufficent definition and justification for the radioactive source terms in the UK ABWR during normal operations.

276. As RI-ABWR-0001 and RO-ABWR-0006 are now closed, and we are satisfied that Hitatchi-GE has provided a suitable and sufficient definition and justification of radioactive source terms for the UK ABWR during normal operations, this potential GDA Issue is no longer needed. Therefore, potential GDA Issue 2 has been removed from our assessment outcomes.

277. During our assessment of the UK ABWR design, it became apparent that a source of discharges to atmosphere had been omitted from the submission. This source was the turbine gland steam system. Jointly with ONR, we raised RO-ABWR-0071 on 6 June 2016, requesting more information on the turbine gland steam system, including gaseous discharges from this system. We have received documents from Hitachi-GE in response to this RO. Hitachi-GE updated its submission to include the BAT justification and estimated discharges from the turbine gland steam system. These discharges have been included in our assessment and RO-ABWR-0071 was closed in November 2016.

278. We conclude that the derivation of estimated gaseous discharges is appropriate, clear and supported by suitable evidence.

279. Hitachi-GE has identified some radionuclides as ‘significant’ for gaseous discharges to the environment and, therefore, important in any future site-specific permitting. Significant radionuclides that may affect people or wildlife are either:

- those discharged in large quantities
- indicators of plant performance
- listed in guidance (EU 2004)

280. Hitachi-GE has identified significant radionuclides based on these criteria, and we are satisfied that the selection of significant radionuclides is appropriate and consistent with our limit setting guidance (Environment Agency, 2012).

281. We conclude that selection of significant radionuclides is appropriate.

282. Hitachi-GE has provided us with proposed limits for discharges of gaseous radioactive waste from UK ABWR (Table 9.1). Limits are proposed for significant radionuclides and are based on discharge estimates for normal operation and include discharges resulting from fuel pin failure.

Table 9.1: Proposed annual rolling limits for gaseous radioactive waste discharges from UK ABWR

Radionuclide	Proposed annual limit for UK ABWR (Bq)
Argon-41(Ar-41)	5.2E+12
Carbon-14 (C-14)	1.7E+12
Tritium (H-3)	1.0E+13
Noble gases (excluding Argon-41)	2.2E+11

283. The proposed limits include a headroom factor that is applied to the discharges from normal operation. The 'headroom factor' is the difference between the estimated discharges and proposed limits. When permitting a new facility, we recognise that there may be considerable uncertainty

regarding the level of discharges to the environment. Therefore, new facilities may have greater headroom than facilities that are already operating.

284. For the UK ABWR, the headroom factor for each radionuclide or radionuclide group has been derived based on the variability of data used to estimate the gaseous discharges. The headroom factors for significant radionuclides range from 1.9 to 3.8. Table 9.2 details annual estimated gaseous discharges and proposed limits for the UK ABWR.

Table 9.2: Estimated annual discharges of significant radionuclides and associated proposed annual limits

Radionuclide	Estimated annual discharge (Bq)	Headroom factor	Discharge from fuel pin failure (Bq)	Proposed annual limit (Bq)
H-3	2.7E+12	3.8	0	1E+13
C-14	9.1E+11	1.9	0	1.7E+12
Ar-41	1.8E+12	2.9	0	5.2E+12
Kr-85	1.0E+08	2.1	1.1E+09	1.3E+09
Kr-85m	2.3E+09		5.5E+09	1.0E+10
Kr-87	2.3E+03		5.0E+03	9.8E+03
Kr-88	1.8E+08		5.5E+08	9.3E+08
Xe-131m	1.4E+08		2.6E+09	2.9E+09
Xe-133	1.0E+10		1.8E+11	2.0E+11
Xe-133m	1.7E+06		1.4E+07	1.8E+07
Xe-135	1.7E-11		3.1E-11	0*
Total for noble gases (excluding Ar-41)				2.2E+11

*Hitachi-GE suggests discharges of Xe-135 do not contribute to the annual limit for noble gases as the discharges of this radionuclide are small.

285. The derivation of proposed gaseous discharge limits for UK ABWR is consistent with our guidance (Environment Agency, 2012) and are of an appropriate order.

286. We conclude that the proposed gaseous discharge limits are of the appropriate order.

Comparison of gaseous discharges with similar reactors worldwide

287. Part of our assessment involved gathering information on radioactive gaseous waste produced from predecessor boiling water reactors (BWRs) and comparing this with the estimated discharges of gaseous radioactive waste from the UK ABWR. This is to ensure that discharges from the UK ABWR do not exceed those of comparable power stations across the world.

288. Since the beginning of nuclear power generation, regulators have required operators of nuclear power stations to take samples, carry out measurements and determine radioactivity in discharges.

289. The main radionuclides or radionuclide groups discharged from nuclear power stations as gaseous waste include:

- tritium (H-3) – a low energy beta emitting radionuclide with a half-life of 12.3 years
- carbon-14 (C-14) – a low energy beta emitting radionuclide with a very long half-life. It can be taken up by crops

- noble gases (isotopes of krypton and xenon, and argon-41) – beta and gamma emitting radionuclides. Half-lives of noble gases vary from a few minutes to years
- iodine radionuclides – several radionuclides of iodine are formed during nuclear fission. The most important of these is iodine-131 (I-131), a beta and gamma emitting radionuclide with a relatively short half-life of 8 days. It can be deposited in crops and then ingested, or can be deposited on grass which is grazed by cows and subsequently appears in milk
- particulates – this group includes fission products such as caesium-137 with a half-life of 30 years, and activated corrosion products such as cobalt-60 with a half-life of 5.3 years

290. We commissioned Public Health England to gather data and information on radioactive discharges from comparable boiling water reactors worldwide. The results of this work are published in our report 'Discharges from boiling water reactors - A review of available discharge data' (Environment Agency, 2016a). The authors obtained discharge data by contacting the relevant operators and regulators or from publicly available sources. To enable comparison of discharges between different reactors, the report presents discharges having normalised them to gigabecquerels per gigawatt-hour (GBq/GWeh) for actual power output. Data was collected for BWRs in Finland, Germany, Japan, Spain, Sweden, Switzerland and USA. In total, data from 24 BWR stations was collected, although data was not available from all stations on all radionuclides.

291. In order to compare discharges from the UK ABWR with those from other BWRs, the UK ABWR discharges have been normalised to gigabecquerels per gigawatt-hour (GBq/GWeh) for maximum power output. Care must be taken not to draw comparisons too closely, as there are many uncertainties in the datasets, including variation in sampling and monitoring techniques between different power stations.

Tritium (H-3)

292. Annual gaseous tritium discharges from BWRs range from 3.4E-06 to 1.5 GBq/GWeh. The UK ABWR estimated annual gaseous tritium discharge is 2.3E-01 GBq/GWeh. Data is presented in Table 9.3 and Figure 9.1.

Table 9.3: Normalised annual gaseous tritium discharges from BWRs and normalised estimated annual gaseous tritium discharges for UK ABWR

(n=number of plants for which data was obtained)

	Year	Mean gaseous H-3 discharges (GBq/GWeh)			n
		Mean	Minimum	Maximum	
BWR	2005	1.6E-01	6.4E-03	5.0E-01	15
	2006	1.7E-01	2.0E-02	6.7E-01	15
	2007	1.5E-01	1.3E-02	5.6E-01	16
	2008	1.1E-01	1.3E-05	3.7E-01	16
	2009	1.3E-01	2.2E-02	4.0E-01	16
	2010	1.4E-01	1.9E-02	5.6E-01	17
	2011	1.0E-01	3.4E-06	3.8E-01	17
	2012	1.8E-01	1.3E-02	1.5E+00	16
	2013	2.1E-01	2.4E-03	1.5E+00	16
UK ABWR		2.3E-01			

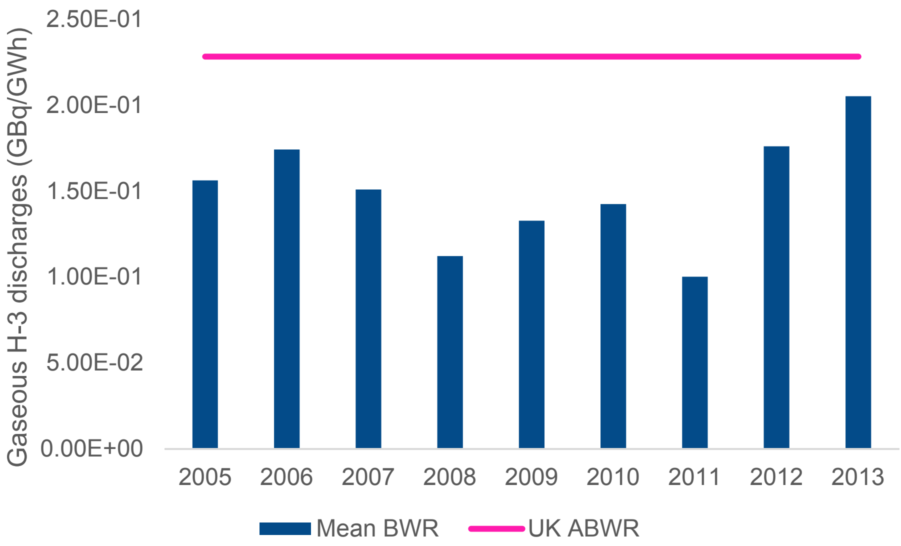

Fig 9.1: Mean normalised annual gaseous tritium discharges for BWRs 2005 – 2013. Pink line shows normalised UK ABWR estimated annual gaseous tritium discharges.

293. Estimated annual discharges of gaseous tritium from the UK ABWR are higher than the mean annual discharges of gaseous tritium from other operating BWRs, but sit within the range of data obtained for operating BWRs. Hitachi-GE suggests that the reason for the apparently high gaseous tritium discharge for the UK ABWR when compared with other reactors is because it has used conservative assumptions when estimating tritium discharges. For tritium discharge estimates, Hitachi-GE has assumed a maximum steam flow rate in the turbine gland steam system that maximises the tritium discharge via this route. However, during operation, the steam flow rate is expected to be lower.

Noble gases

294. Annual noble gas discharges from BWRs range from 4.8E-06 to 1.6E+01 GBq/GWeh. The UK ABWR estimated annual noble gas discharge, with and without fuel pin failure, is 1.7E-01 and 1.5 E-01 GBq/GWeh respectively. Data is presented in Table 9.4 and Figure 9.2.

Table 9.4: Normalised annual noble gas discharges from BWRs and normalised estimated annual noble gas discharges for UK ABWR

(n=number of plants for which data was obtained)

	Year	Mean noble gas discharges (GBq/GWeh)			n
		Mean	Minimum	Maximum	
BWR	2005	1.5E+00	2.7E-02	1.6E+01	15
	2006	1.1E+00	1.0E-05	7.2E+00	17
	2007	1.2E+00	1.4E-02	5.1E+00	15
	2008	8.0E-01	4.8E-06	3.5E+00	15
	2009	1.1E+00	5.8E-03	7.9E+00	14
	2010	6.7E-01	4.8E-03	3.7E+00	19

	2011	7.5E-01	8.1E-04	4.6E+00	18
	2012	8.7E-01	3.3E-03	7.0E+00	15
	2013	7.8E-01	5.9E-04	6.6E+00	16
UK ABWR (no fuel pin failure)		1.5E-01			
UK ABWR (fuel pin failure)		1.7E-01			

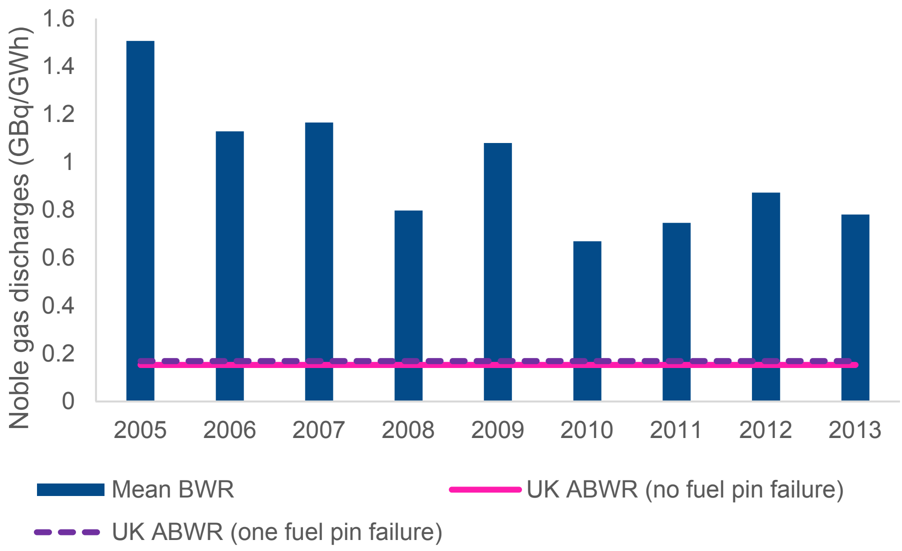

Fig 9.2: Mean normalised annual noble gas discharges from BWRs 2005 – 2013. Solid pink line shows normalised UK ABWR estimated annual noble gas discharges with no fuel pin failure. Dashed line shows normalised UK ABWR estimated annual noble gas discharges with 1 fuel pin failure.

295. Estimated annual discharges of noble gases from the UK ABWR are lower than the mean annual discharges of noble gases from other operating BWRs and sit at the lower end of the range of data obtained for operating BWRs.

Iodine radionuclides

296. Annual gaseous discharges of iodine radionuclides from BWRs range from 7.3E-11 to 2.1E-02 GBq/GWeh. The UK ABWR estimated annual gaseous discharge of iodine radionuclides is 2.7E-05 GBq/GWeh. Data is presented in Table 9.5 and Figure 9.3.

Table 9.5: Normalised annual gaseous discharges iodine radionuclides from BWRs and normalised estimated annual gaseous discharges of iodine radionuclides for UK ABWR

(n=number of plants for which data was obtained)

	Year	Mean gaseous discharges of iodine radionuclides (GBq/GWeh)			n
		Mean	Minimum	Maximum	
BWR	2005	8.5E-05	7.3E-11	8.0E-04	17
	2006	2.4E-04	1.6E-08	3.0E-03	17

	2007	2.0E-04	4.7E-09	2.3E-03	18
	2008	8.2E-05	1.8E-07	6.6E-04	14
	2009	1.2E-04	7.3E-09	1.2E-03	17
	2010	1.3E-03	1.1E-07	2.1E-02	19
	2011	2.4E-04	6.5E-08	3.0E-03	22
	2012	2.1E-05	1.8E-08	1.2E-04	15
	2013	2.9E-05	1.4E-07	1.3E-04	14
UK ABWR		2.7E-05			

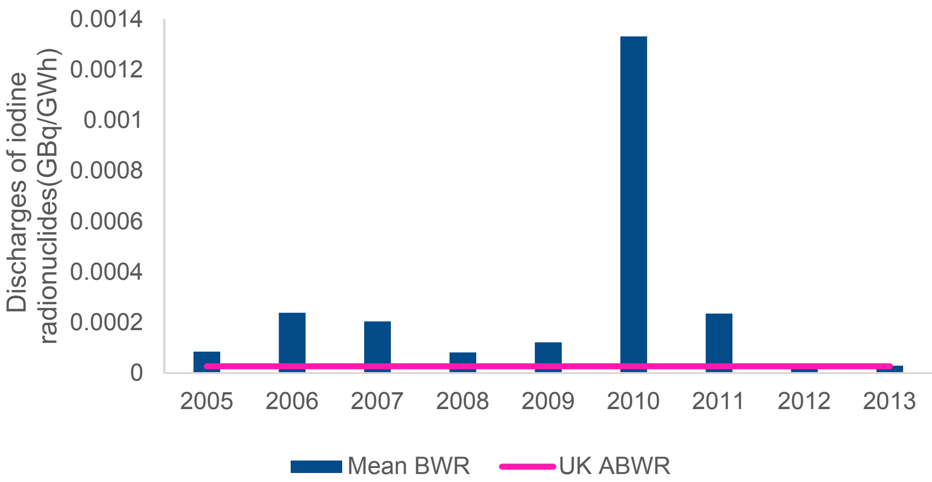

Fig 9.3: Mean normalised annual gaseous discharges of iodine radionuclides from BWRs 2005 – 2013. Pink line shows normalised UK ABWR estimated annual gaseous iodine radionuclides discharges.

297. Estimated annual discharges of gaseous iodine radionuclides from the UK ABWR are lower than the mean annual discharges of gaseous iodine radionuclides from other operating BWRs and sit at the lower end of the range of data obtained for operating BWRs.

Particulates

298. Annual airborne particulate discharges from BWRs range from 1.3E-13 to 1.6E-04 GBq/GWeh. The UK ABWR estimated annual airborne particulate discharge is 2.1E-08 GBq/GWeh. Data is presented in Table 9.6 and Figure 9.4.

Table 9.6: Normalised annual airborne particulate discharges from BWRs and normalised estimated annual airborne particulate discharges for UK ABWR

(n=number of plants for which data was obtained)

	Year	Mean gaseous particulate discharges (GBq/GWeh)	n

		Mean	Minimum	Maximum	
BWR	2005	9.1E-06	1.7E-08	4.8E-05	16
	2006	1.6E-05	2.2E-07	1.6E-04	15
	2007	9.5E-06	2.0E-08	7.9E-05	17
	2008	5.7E-06	3.9E-09	2.7E-05	17
	2009	1.1E-05	2.2E-08	3.4E-05	16
	2010	9.2E-06	6.9E-09	3.6E-05	15
	2011	5.7E-06	5.0E-09	2.2E-05	16
	2012	4.5E-06	1.3E-13	2.3E-05	16
	2013	4.8E-06	2.2E-09	3.1E-05	16
UK ABWR		2.1E-08			

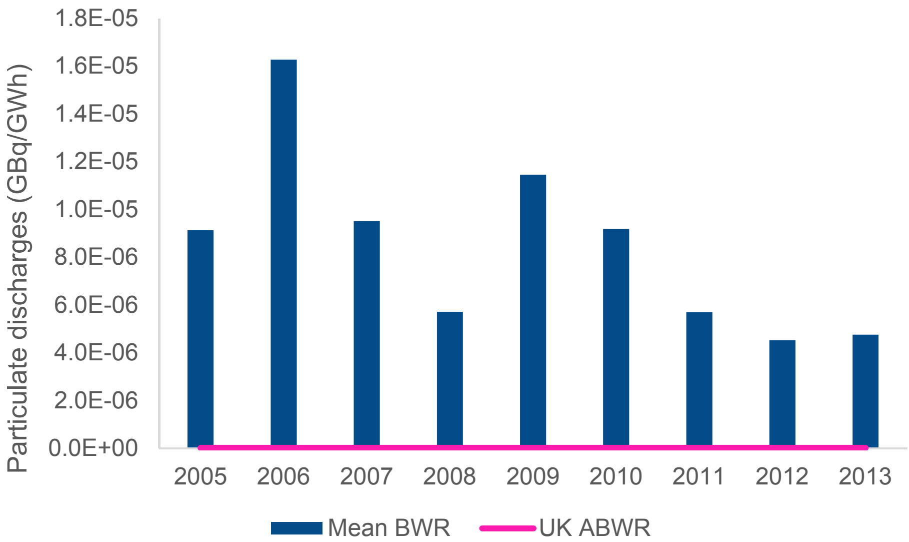

Fig 9.4: Mean normalised annual airborne particulate discharges from BWRs 2005 – 2013. Pink line shows normalised UK ABWR estimated annual airborne particulate discharges.

299. Estimated annual discharges of airborne particulates from the UK ABWR are lower than the mean annual discharges of airborne particulates from other operating BWRs and sit at the lower end of the range of data obtained for operating BWRs.

Carbon-14

300. Annual gaseous carbon-14 discharges from BWRs range from 4.1E-03 to 1.1E-01 GBq/GWeh. The UK ABWR annual gaseous carbon-14 discharge is 7.7E-02 GBq/GWeh. Data is presented in Table 9.7 and Figure 9.5.

Table 9.7: Normalised annual gaseous carbon-14 discharges from BWRs and normalised estimated annual carbon-14 discharges for UK ABWR

(n=number of plants for which data was obtained)

	Year	Mean gaseous carbon-14 discharges (GBq/GWeh)	n

		Mean	Minimum	Maximum	
BWR	2005	5.8E-02	3.1E-02	1.1E-01	5
	2006	4.6E-02	4.1E-03	1.0E-01	5
	2007	7.1E-02	4.2E-02	1.1E-01	6
	2008	5.6E-02	3.4E-02	9.9E-02	6
	2009	5.9E-02	3.7E-02	9.0E-02	6
	2010	5.5E-02	3.6E-02	1.0E-01	17
	2011	6.0E-02	3.4E-02	8.9E-02	17
	2012	5.7E-02	5.2E-03	8.3E-02	16
	2013	6.1E-02	1.4E-02	8.2E-02	16
UK ABWR		7.7E-02			

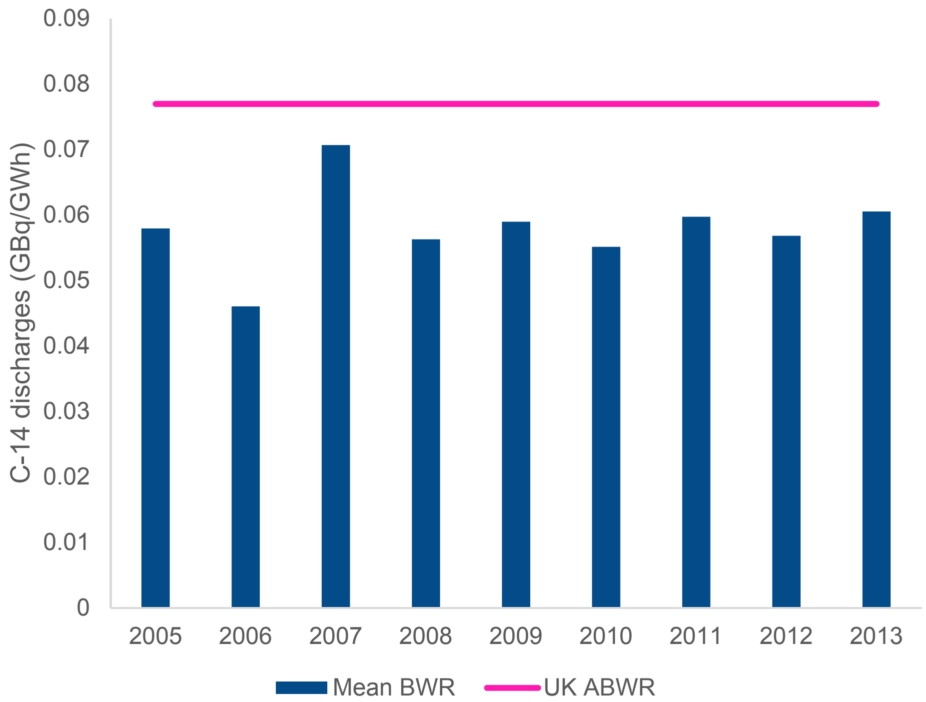

Fig 9.5: Mean normalised annual gaseous carbon-14 discharges from BWRs 2005 – 2013. Pink line shows normalised UK ABWR estimated annual gaseous carbon-14 discharges.

301. Estimated annual discharges of gaseous carbon-14 from the UK ABWR are higher than the mean annual discharges of gaseous carbon-14 from other operating BWRs but sit within the range of data obtained for operating BWRs. Conservatisms in the assessment of estimated carbon-14 discharges result in the apparently higher estimated discharges of carbon-14 from the UK ABWR when compared to other operating plants. Hitachi-GE has assumed that all carbon-14 is discharged via the gaseous route and that none enters the liquid waste streams. In addition, Hitachi-GE has not made any claim on retention of carbon-14 by the charcoal adsorbers. In reality, some gaseous carbon-14 may be abated by the charcoal adsorbers.

Conclusion of comparison of gaseous discharges with similar reactors worldwide

302. Estimated gaseous discharges of noble gases, iodine radionuclides and airborne particulates from the UK ABWR are lower than mean gaseous discharges for operating BWRs. Gaseous discharges of tritium and carbon-14 from the UK ABWR are higher than the mean discharges from operating BWRs, but still sit within the range of data values obtained. The estimated gaseous discharges for the UK ABWR are derived in a conservative way, and we expect actual UK ABWR discharges to be smaller than these estimates.

303. We conclude that gaseous radioactive discharges from the UK ABWR will not exceed those of comparable power stations across the world.

Our overall conclusions on gaseous radioactive waste

304. We conclude that:

- gaseous radioactive discharges arising from all modes of normal operation have been considered
- all appropriate radionuclides have been considered in deriving estimated gaseous discharges
- estimated gaseous discharges are clear and supported by suitable evidence
- the selection of significant radionuclides is appropriate
- the proposed gaseous discharge limits are of an appropriate order
- the gaseous discharges from the UK ABWR will not exceed those of comparable power stations across the world and will be capable of meeting the limits set out below

Radionuclide or group of radionuclides	Annual limit (Bq)
Argon-41 (Ar-41)	5.2E+12
Carbon-14 (C-14)	1.7E+12
Tritium (H-3)	1.0E+13
Noble gases (excluding Argon-41)	2.2E+11

305. We have raised no GDA Issues or Assessment Findings in this area.

You can find more details of our assessment of gaseous radioactive waste in our report [AR04 - Assessment of gaseous radioactive waste disposal and limits] (Environment Agency, 2017d).

10. Aqueous discharges of radioactive waste

This chapter covers our assessment of the aqueous discharge limits that the UK ABWR should be able to comply with and that we might include in any permit issued for a power station of this design.

We conclude that:

- all sources of aqueous radioactive waste have been identified
- the assumed decontamination factors (DF) are conservative and appropriate for the abatement technique to which they are applied, however, for site-specific permitting we would expect to see a thorough options study for selecting filter type and ion exchange media
- the appropriate nuclides have been considered for discharges in line with relevant guidance
- the selection of significant radionuclides for aqueous discharge is appropriate and in line with relevant guidance
- the proposed aqueous discharge limits are of the appropriate order
- the aqueous discharges from the UK ABWR will not exceed those of comparable power stations across the world and will be capable of meeting the limit set out below

Radionuclide or group of radionuclides	Annual limit (GBq)
Tritium (H-3)	760

We have identified 2 Assessment Findings:

- **Assessment Finding 7**: A future operator shall provide an evidence based definition of the decontamination factors likely to be achieved for aqueous effluent treatment prior to operation and then compare these with the actual decontamination factors achieved during operation. Differences in expected and actual decontamination factors should be explained.
- **Assessment Finding 8**: A future operator shall assess the chemical speciation of radioactivity in aqueous discharges. It shall consider the implications of this for the receiving environment so that discharges are shown to represent best available techniques.

Please read below for a summary of our detailed assessment and links to further supporting documents.

Sources of aqueous radioactive waste and minimisation of radioactivity in discharges

307. As for gaseous radioactive waste, we expect new nuclear power stations to use BAT to minimise the radioactivity in discharges of aqueous radioactive waste, and to minimise the impact of those discharges on the environment.

308. Information on the sources of aqueous radioactive wastes, the quantification of arisings and discharges, and Hitachi-GE's proposed limits is provided in:

- Hitachi-GE's ‘Quantification of discharges and limits’ submission
- Sections 5.2.6, 5.2.7, 5.2.8, 5.2.9 and 5.5.2 of Hitachi-GE's ‘Demonstration of BAT’ submission

309. We carried out our initial assessment on Revision D of the generic environmental permit (GEP) submission, which was issued on 6 August 2014. Our initial assessment feedback (Environment Agency, 2014b) noted that some further information would be needed to undertake the detailed assessment, specifically:

- appropriate and robust evidence was required to support the estimates of aqueous (and gaseous) discharges which we raised jointly with ONR in RO-ABWR-0006 and RI-ABWR-0001
- details on the contribution that each constituent of normal operations (such as maintenance and testing) makes to discharges
- demonstration that expected discharges will not exceed those of comparable power stations across the world

310. Ongoing discussion of Revision D of Hitachi-GE's submission resulted in additional RQs relating to discharge variability, monthly discharges and the BAT aspects of the liquid waste management system. The outstanding information has now been provided in response to the RQs and incorporated into the GDA submissions where appropriate.

311. At the time of writing the consultation document (5 August 2016; Environment Agency and Natural Resources Wales, 2016a), both RI-ABWR-0001 and RO-ABWR-0006 remained open. A workshop was held between 26 and 29 July 2016 to discuss progress in this area. Information Hitachi-GE provided is adequate and our technical assessor and ONR inspectors recommended closure of RI-ABWR-0001 to the GDA project.

312. However, until the RI and RO were formally closed, the estimated gaseous and aqueous radioactive discharges, estimated solid radioactive waste arisings, decommissioning source term and radiological impact assessments could potentially have changed and impacted on our draft conclusions on the acceptability of the UK ABWR design. Therefore, we had previously identified a potential GDA Issue relating to the source term.

313. The RI-ABWR-001 and RO-ABWR-0006 are both now formally closed and both regulators are satisfied that the source term has been defined and underpinned to their satisfaction.

314. We have now removed this potential GDA Issue from our final assessment.

Sources of aqueous waste

315. There are 4 aqueous radioactive waste streams:

- low chemical impurity waste (LCW)
- high chemical impurity waste (HCW)
- laundry drain (LD)
- controlled area drain (CAD)

316. Of these 4 aqueous waste management streams only HCW (including liquid from the controlled area drains if activity has been detected) and LD have a route to discharge to the environment. Both types of waste are discharged via the same discharge pipe where they are mixed with the cooling water before being discharged to the marine environment.

317. HCW waste will be recycled where possible and will only be discharged when there is no capacity in the condensate storage tank (CST) where recycled wastes are stored for reuse in the reactor circuit. HCW is treated, before being reused or discharged, using evaporation to remove insoluble species and demineralisation to remove soluble ionic species. Secondary wastes from this process are transferred to the solid waste management systems. Discharge of HCW is expected to be a maximum volume of 560 m^3/y based on the conservative assumption that all HCW generated will be discharged. We believe that this conservative approach is appropriate for the purposes of GDA

and note that the discharges from an operating unit would be expected to be lower than those stated in Hitachi-GE's GDA submission.

318. The LD liquid waste is not suitable for recycling into the reactor circuit and is discharged to the environment following treatment using activated carbon adsorption and filtration. Secondary wastes are transferred to the solid waste management systems. Discharges from LD are expected to be 2,240 m^3/y.

319. We conclude all sources of liquid radioactive waste within the scope of GDA have been identified.

320. There are a number of assumptions made in the source term work that are important to the expected liquid discharges. These are:

- tritium partitions within the reactor, 50% each to the steam and water
- tritium is not reduced by any of the abatement techniques employed on the UK ABWR
- 100% of the carbon-14 is partitioned into the gaseous waste stream

321. The assumptions relating to tritium are as expected and the proposed treatments are not effective for tritium abatement. However, the assumption that no carbon-14 enters the aqueous waste streams or adsorbs onto the demineraliser resins is not a conservative assumption as far as aqueous discharges are concerned and may need considering further in the future or validating at an early stage in the operation. We have recorded this requirement as an Assessment Finding (AF5) in our assessment of BAT.

322. Estimated activity concentrations for each waste stream, for relevant nuclides as recommended in the EC recommendation on standardised reporting of discharges from nuclear power stations (EU, 2004) are presented in Hitachi-GE's 'Quantification of discharges and limits' submission (Table 7.2-2).

323. The physico-chemical form of a radionuclide on entering the environment and the environment into which it is discharged can influence its behaviour and transportation and, therefore, the resulting public exposure to radiation. For example, tritium can take the form of tritiated water or organically bound tritium. It is noted that the generic environmental permit (GEP) submission contains no discussion on the typical physico-chemical speciation of activity within the aqueous wastes discharged, which may be important to understanding the localised impact at site-specific permitting. We have included an Assessment Finding to ensure future consideration is given to this aspect.

- **Assessment Finding 8**: A future operator shall assess the chemical speciation of radioactivity in aqueous discharges. It shall consider the implications of this for the receiving environment so that discharges are shown to represent best available techniques.

324. Hitachi-GE has not specified a specific filter or ion exchange resins for GDA and notes that the decision will be made by the operator. Therefore, to derive the discharges it needed to make an assumption of the decontamination factor (DF) achieved in abatement, Hitachi-GE has assumed the LCW will have a mixed bed ion exchanger capable of a DF of 100 for soluble species and 10 for insoluble species. Filters are assumed to have DF of 1 for soluble species and 10 for insoluble species as stated in Hitachi-GE's process source term supporting report (Hitachi-GE, 2016a). The evaporator is expected to achieve a DF of between 1,000 and 10,000 as stated in Hitachi-GE's 'Demonstration of BAT' submission.

325. The LD effluent is abated using an activated carbon adsorption tower and filtration. An activated carbon adsorption technique is used due to the organic component of the LD effluent. The activated carbon is assumed to have minimal DF for activity, assuming a DF of 1 for soluble species and 3 for insoluble species (Hitachi-GE's process source term supporting report - Hitachi-GE, 2016a). That is because the activated carbon tower also acts as a filter, trapping particulates. The pre-filter is assumed to have a DF of 2 for insoluble species and the final filter a DF of 50 for insoluble species. Soluble activity is not removed by the LD abatement system. However, activity concentrations in this waste stream are expected to be very low.

326. We conclude that the proposed abatement techniques are appropriate as they are standard abatement techniques in the nuclear industry for treating reactor effluent and are proven technologies.

327. We conclude that the assumed DFs are appropriate for the abatement technique to which they are applied. However, we would expect a future operator to provide a thorough options selection study for filter type and ion exchange media and an evidence based understanding of what DFs are likely to be achieved. Therefore, we have included the following Assessment Finding.

- **Assessment Finding 7**: A future operator shall provide an evidence-based definition of the decontamination factors likely to be achieved for aqueous effluent treatment prior to operation and then compare these with the actual decontamination factors achieved during operation. Differences in expected and actual decontamination factors should be explained.

Discharges

328. Hitachi-GE presented estimated discharges for each waste stream for relevant nuclides as recommended by the European Commission (EU, 2004) in its ‘Quantification of discharges and limits’ submission (Table 7.2-4).

329. We conclude that the appropriate nuclides have been considered for discharges.

330. The aqueous discharge activity is dominated by tritium (H-3), which is not abated and constitutes over 99.99% of the activity discharged. The second largest contributor of activity to the discharges is iron-55 (Fe-55), which only constitutes 0.0009% of the activity discharged.

Limit setting

331. We expect limits to be set on a 12-month rolling basis and for each nuclide or group of nuclides deemed significant based on the criteria in our guidance (Environment Agency, 2012). Limits set an upper bound on the amount of radioactive waste that an operator may discharge into the environment. The difference between the estimated discharges and proposed limits is referred to as the ‘headroom factor’.

332. For an operating station the headroom factor can be determined by assessing the variability in discharges necessary during normal operations. However, for a new plant this data does not yet exist. Therefore, Hitachi-GE, in its submission, has taken a statistical approach based on the derivation of the source term. Hitachi-GE has looked at the data used to derive the primary source term to assess the likely variability of the discharges and, therefore, the likely headroom factor required.

333. There are some important underlying assumptions used in this approach:

- the variability in discharges will have a linear relationship to the variability in the primary source term data
- the available OPEX data are normally distributed

334. Hitachi-GE has provided some justification to support these assumptions in response to a Regulatory Query we raised.

335. The headroom factors calculated range from 1.7 to 4.1 and are considered to be reasonable yet conservative, which is acceptable for new build facilities. However, we would expect these to be reviewed during early operation of the plant, with a view to reducing the headroom factors and, therefore, the proposed discharge limits.

336. We conclude that the proposed liquid discharge limits are of the appropriate order of magnitude.

337. The following sections summarise our assessment for individual radionuclides and groups.

Significant nuclides

338. Hitachi-GE has selected significant nuclides based on the appropriate Environment Agency guidance on the criteria for setting limits on the discharge of radioactive waste from nuclear sites (Environment Agency, 2012).

339. We conclude that the selection of significant radionuclides for liquid discharge is appropriate.

340. Tritium is the only significant nuclide that needs a proposed limit in a future permit. The proposed limit, to be applied on a rolling 12-month basis, is 760 GBq/y.

341. We note that there are no other nuclides identified because activity concentrations for parameters such as total beta/gamma are too low to monitor using currently available equipment. However, if monitoring technology were to improve or the source term change, we would expect the operator to review this.

Comparing aqueous discharges with similar reactors worldwide

342. Tritium discharges for comparable reactors, normalised for electrical power output, were taken from our report 'Discharges from boiling water reactors - A review of available discharge data' (Environment Agency, 2016a).

343. The mean discharges (normalised) were compared to those estimated from the UK ABWR, also normalised for energy output (Table 10.1 and Figure 10.1). For tritium, the predominant nuclide in aqueous discharges, the UK ABWR estimated discharges are significantly less than those of existing BWRs and ABWRs.

Table 10.1 - Normalised annual tritium discharges from BWRs (mean values) and UK ABWR

	Year	Mean aqueous liquid tritium discharges (GBq/GWeh)			n
		Mean	Minimum	Maximum	
BWR	2005	1.2E-01	2.6E-04	5.5E-01	18
	2006	9.9E-02	1.0E-03	5.0E-01	20
	2007	1.3E-01	5.3E-04	6.8E-01	19
	2008	1.1E-01	5.0E-04	4.5E-01	19
	2009	1.1E-01	6.6E-03	3.1E-01	19
	2010	9.7E-02	1.6E-03	4.7E-01	20
	2011	1.2E-01	3.9E-03	3.6E-01	19
	2012	1.5E-01	3.3E-02	5.1E-01	13
	2013	1.3E-01	7.7E-03	2.9E-01	12
UK ABWR		2.0E-02			

(n=number of plants for which data were obtained)

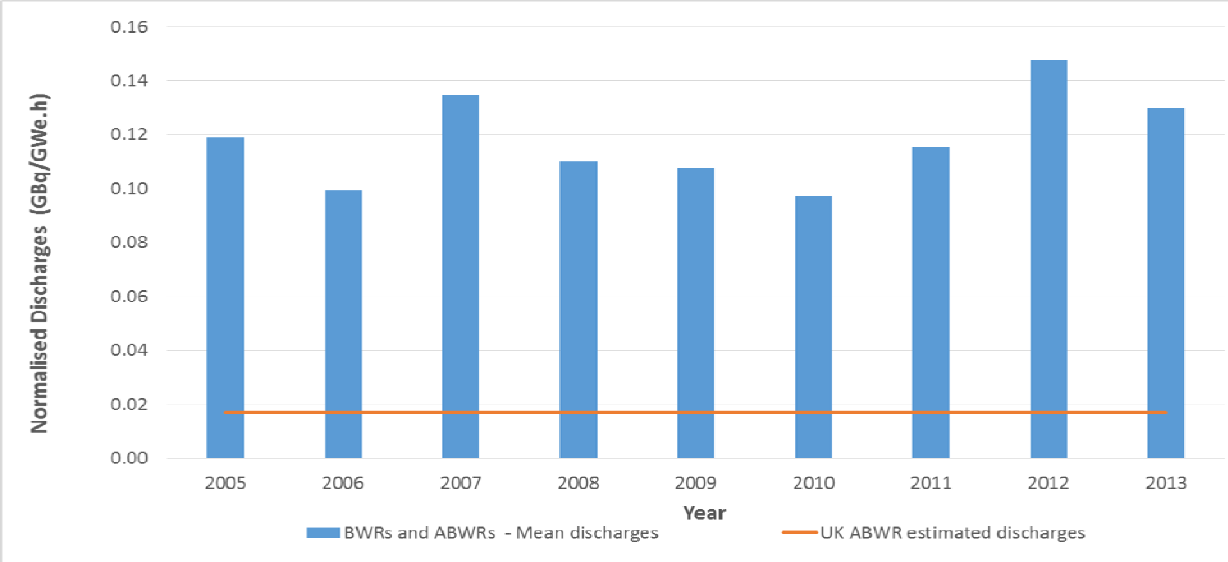

Figure 10.1 – mean normalised discharges from BWRs 2005-2013.

345. We conclude that the aqueous discharges from the UK ABWR will not exceed those of comparable power stations across the world.

Our overall conclusions on aqueous radioactive waste

346. We conclude that:

- all sources of aqueous radioactive waste have been identified
- the assumed decontamination factors (DF) are conservative and appropriate for the abatement technique to which they are applied. However, for site-specific permitting, we would expect to see a thorough options study for selecting filter type and ion exchange media
- the appropriate nuclides have been considered for discharges in line with relevant guidance
- the selection of significant radionuclides for aqueous discharge is appropriate and in line with relevant guidance
- the proposed aqueous discharge limits are of the appropriate order
- the aqueous discharges from the UK ABWR will not exceed those of comparable power stations across the world and will be capable of meeting the limit set out below

Radionuclide or group of radionuclides	Annual limit (GBq)
Tritium (H-3)	760

347. We have identified 2 Assessment Findings, as set out at the beginning of this chapter.

More details of our assessment of aqueous radioactive waste are provided in our report [AR05 - Assessment of aqueous radioactive disposal and limits] (Environment Agency, 2017e).

11. Solid radioactive waste

This chapter covers our assessment of:

- the techniques Hitachi-GE proposes to use to minimise the quantity of solid radioactive waste
- the proposed disposal routes for lower activity solid waste
- the management of higher activity solid waste and spent fuel

Minimising the quantity (mass and volume) of solid waste means the limited disposal facilities that are available can be better used. It also minimises the environmental impacts of transporting the waste to those facilities. There are also benefits in terms of use of uranium resources and sustainability.

Currently, there are no final disposal facilities for higher activity wastes (HAW) and spent fuel, but it is expected that these will be disposed of to a geological disposal facility (GDF) that the government intends will be constructed (GB Parliament, 2014). The wastes and spent fuel need to be suitably managed until the GDF is available.

We include non-aqueous liquid wastes, such as oils and solvents, in our assessment of solid wastes, as they need to be managed and disposed of in similar ways.

We conclude that:

- in its submissions, Hitachi-GE describes how solid radioactive waste (low level waste (LLW), intermediate level waste (ILW)) and spent fuel will be generated, managed and disposed of throughout the facility's life cycle at a level of detail in line with our expectations for GDA
- the quantities of solid waste produced by the UK ABWR are comparable to other light water reactor power stations across the world
- the UK ABWR design uses BAT to minimise the quantity (mass and volume) of solid radioactive waste that will need to be disposed of
- solid radioactive waste will be treated and conditioned using proven and recognised techniques
- potential disposal routes have been identified for all LLW solid wastes
- Hitachi-GE has provided information on the fuel composition and characteristics, the expected fuel burn up and the quantities of spent fuel that will be generated, and described how spent fuel will be managed and disposed of throughout the life cycle of a UK ABWR at a level of detail in line with our expectations for GDA
- the proposed arrangements for interim management of higher activity solid wastes and spent fuel are unlikely to prevent their ultimate disposal based on the conceptual options that have been described to date
- Hitachi-GE has obtained a view from Radioactive Waste Management (RWM) Ltd (as the UK authoritative source in providing such advice) on the disposability of ILW and spent fuel, responded to RWM's advice and provided an opinion to the regulators

We have identified 2 Assessment Findings:

- **Assessment Finding 9**: A future operator shall, before procurement, provide detailed designs for solid radioactive waste management, storage and conditioning facilities that were covered at a conceptual level during generic design assessment, and demonstrate how these represent best available techniques.

- **Assessment Finding 10**: A future operator shall demonstrate optimised management and disposal of solid radioactive wastes from the UK ABWR, addressing in particular:
    - o conditioning of higher activity waste arisings to ensure disposability
    - o selection of disposal routes for wastes at the low activity waste/high activity waste boundary
    - o management of spent nuclear fuel and any associated secondary wastes to ensure disposability
    - o selection of disposal routes for low activity waste

Please read below for a summary of our detailed assessment and links to further supporting documents.

Sources of solid radioactive waste

348. Hitachi-GE has outlined the sources and quantities of solid radioactive waste that are likely to be generated in its 'Radioactive waste management arrangements' submission (Hitachi-GE 2017d). This document also outlines the proposed management arrangements covering the UK ABWR life cycle, including decommissioning. Coverage includes the generation, management and disposal of solid wastes. The solid radioactive waste inventory is presented in Appendix A of Hitachi-GE's 'Radioactive waste management arrangements' submission. More detailed inventory data relating to solid wastes is provided in Hitachi-GE's reports 'Solid waste generation arising from operation and decommissioning (Hitachi-GE, 2017f) and 'Calculation of radioactive waste end user source term value' (Hitachi-GE, 2016b).

349. Hitachi-GE has identified a wide range of solid waste arisings in its submission and has categorised these according to UK practice and based on physical form and the nature and quantity of radioactivity that they contain, as well as their heat-generating capacity**.** A brief summary of the solid wastes and their proposed management and disposal routes is provided below.

350. Solid wastes will arise within the nuclear plant and will also be managed, stored and conditioned for eventual disposal in dedicated waste management facilities. The radioactive waste building will house equipment associated with collecting, segregating and treating the liquid and wet solid radioactive waste generated in the plant.

351. Certain waste management facilities are defined only at a conceptual level in GDA, to illustrate the requirements and capabilities that will be needed to enable waste management operations and disposal. Hitachi-GE has identified the following conceptual facilities: wet solid low level waste (WLLW), dry solid low level waste in the solid waste facility (SWF), wet solid intermediate level waste (WILW), solid ILW (SILW) facilities, ILW store (ILWS) and a spent fuel interim store (SFIS) with co-located high level waste (HLW) store. It describes these further in its 'Radioactive waste management arrangements' submission (Hitachi-GE 2017d). We have, therefore, included an assessment finding to ensure that a future operator will provide detailed designs for solid waste management facilities.

- **Assessment Finding 9**: A future operator shall, before procurement, provide detailed designs for solid radioactive waste management, storage and conditioning facilities that were covered at a conceptual level during generic design assessment, and demonstrate how these represent best available techniques.

Very low level waste (VLLW)

352. VLLW is a sub-category of LLW that is suitable for disposal in small volumes with non-radioactive wastes or at permitted landfills for larger volumes (UKRWI, 2017).

353. VLLW will comprise mixed waste that will arise during reactor operations and decommissioning. This waste will consist of contaminated personal protection equipment, monitoring swabs, plastic, equipment, structures and contaminated plant. Different forms of VLLW will require specific removal, handling, sorting and size reduction techniques depending on their physical form and characteristics prior to treatment and disposal.

354. Projected amounts of waste are 14 m^3/year (combustible) and 3.4 m^3/year (non-combustible) ('Radioactive waste management arrangements' submission) (Hitachi-GE, 2017c). The radionuclide content of such wastes are dependent upon where they are generated but will mainly comprise steel activation products.

355. It is proposed that such wastes will be recycled where practicable (for metals), compacted, incinerated, where possible, or directly disposed of at permitted disposal sites. Any future operators will need to select appropriate disposal routes.

Low level waste (LLW)

356. LLW is defined as waste with a radioactive content not exceeding 4 GBq per tonne of alpha, or 12 GBq per tonne of beta/gamma activity.

357. Hitachi-GE states that operational LLW is mainly lightly contaminated miscellaneous waste, arising from plant maintenance and monitoring. Routine LLW arisings from plant consumables will include HVAC filters, organic bead demineraliser resin and concentrate liquors from the HCW evaporators.

358. Non-combustible wastes are generated through routine operations, maintenance and decommissioning in radioactive areas. These will comprise materials such as metals, concrete, lagging, glass and LCW spent hollow fibre filter membrane. These types of wastes may include some items that could be dealt with in ways other than being directly disposed of. Hitachi-GE envisages that future operators will apply the requirements of the waste hierarchy to enable appropriate waste routings.

359. Miscellaneous combustible wastes are generated through routine operations, maintenance and decommissioning in radioactive areas. The waste consists mainly of contaminated personal protective equipment, polyethylene (sheet, bag), paper, wood, cloth, rubber gloves, turbine oil waste and spent active carbon filter media. Subject to future operators disposing of waste appropriately, it is envisaged that these types of waste will be incinerated at an off-site facility, with the resulting ash disposed of at an appropriate facility.

360. Wastes that are generated as wet material but could be made into solid waste for disposal are known as 'wet-solid' LLW. This includes sludge, ion exchange resin, evaporator concentrates and activated carbon. Subject to appropriate waste routing by future operators it is envisaged that these types of waste will be solidified by being encapsulated in cement on site for disposal to LLWR.

361. LLW from decommissioning typically includes building materials (concrete), metal plant and equipment. This will comprise large volumes of metal and concrete items. Much of this waste will be very large and need reducing in size. Hitachi-GE recognises that segregating waste based on composition, radioactivity and contamination will be needed and that future operators will need to apply appropriate treatment and disposal strategies.

362. The Hitachi-GE submission broadly categorises LLW into 'dry-solid LLW' and 'wet-solid LLW', and estimates of annual arisings are provided, together with information as to the significant radionuclide inventory components.

363. Total low level waste arisings of around 84 m^3/year are envisaged, comprising 71 m^3/year dry-solid LLW and 13 m^3/year wet-solid LLW. The most significant volumes are associated with HVAC filters (around 24 m^3/year), miscellaneous combustible LLW (37 m^3/year) and wet solid LLW (13 m^3/year) (Hitachi-GE, 2017c).

364. Hitachi-GE proposes that, where practicable, LLW will be subject to metals treatment, incineration, super compaction and disposal. This will depend on a future operator applying the waste hierarchy appropriately and using the optimal disposal routes.

365. Hitachi-GE observes that specific waste streams are likely to need considering as 'borderline' wastes (close to the LLW and ILW categorisation boundary) in the future. Organic bead demineraliser resins used in liquid clean up plant is one example of this type of waste. Any future operators will need to assess borderline wastes using a methodology agreed with the disposal site operators and UK regulators, as appropriate.

Intermediate level waste (ILW)

366. ILW has radioactivity levels that are higher than LLW but do not generate enough heat to require special storage or disposal facilities, such as HLW. The Hitachi-GE submission identifies a range of ILW that will be generated by a UK ABWR. These will broadly comprise 'dry-solid' ILW and 'wet-solid' ILW.

367. Dry-solid ILW comprises activated metals subjected to irradiation to the extent that it becomes significantly active (above LLW levels) within the reactor. These wastes will include control rods and reactor components, such as neutron sources and metallic fuel channels. Metallic components of fuel assemblies are envisaged to be retained and disposed with the associated spent fuel (timescales of up to 140 years are envisaged for spent fuel storage). Although it could potentially be HLW when it is generated, Hitachi-GE expects such dry-solid wastes to be ILW when they are disposed of due to radioactive decay and cooling during storage (timescales of up to 100 years are envisaged). The main radionuclides include cobalt-60, nickel-63 and californium-252 in neutron sources.

368. Wet-solid ILW includes 90 m^3 (per 60 year operational life) of sludge (also referred to as 'crud') arising from filtration of water streams and 4.4 m^3/year of powder ion exchange resins (arising from water treatment filter/demineralisers associated with the fuel pool and reactor clean up circuit) ('Radioactive waste management arrangements' submission) (Hitachi-GE, 2017c).

369. Hitachi-GE has identified that some irradiated metals, including control rods and various reactor core components, will be generated as high level waste (that is, having significant heat output). Hitachi-GE has assumed that storing this type of waste will mean that it can be treated as ILW when it is disposed of (decay storage is proposed).

370. Hitachi-GE has selected the option of cement encapsulation for solid items and solidification with cement for wet-solid ILW, within unshielded stainless steel containers, as the conditioning option to be adopted for a disposability assessment by RWM. Interim storage for up to 100 years is assumed awaiting disposal to the GDF (see Chapter 6 - Strategic considerations for radioactive waste management).

Spent fuel

371. Spent or used fuel is considered as waste in GDA on the basis of an assumed once-through nuclear cycle. This is consistent with the policy, laid out in the government White Paper 'Meeting the energy challenge' (BERR, 2008), that new nuclear power stations should proceed on the basis that spent fuel will not be reprocessed. Hitachi-GE's proposed spent fuel management strategy for the UK ABWR comprises initial pool cooling, followed by dry storage and eventual geological disposal in a GDF (see Chapter 6 - Strategic considerations for radioactive waste management).

372. Hitachi-GE proposes using GE14 fuel in the UK ABWR. This is a modern fuel design that has benefitted from progressive development and optimisation of BWR fuel design; see Claim 1 - in assessment report AR03 - Assessment of best available techniques (Environment Agency, 2017c). GE14 fuel consists of a fuel bundle (composed of 92 fuel rods, 2 water rods, spacers and upper and lower tie plates), and a channel that surrounds the fuel bundle. The fuel is in the form of uranium dioxide (UO_2) pellets that are stacked in a zirconium alloy cladding tube to form fuel rods.

373. A GE14 fuel assembly consists of a fuel bundle and a channel that surrounds it. All components of the assembly will become spent fuel waste. It is proposed that the channels that surround each of the fuel element bundles are to remain with the spent fuel to be disposed of together.

374. Significant radioactivity arises in spent fuel within the reactor core by nuclear fission, activation and growth of radionuclides. Much of this activity remains within the fuel, which will contain fission products, activation products and actinides. Approximately 9,600 assemblies are assumed to arise over 60 years' of operation. Interim storage periods of up to 140 years are assumed, awaiting disposal to the GDF.

375. Spent fuel generates considerable radiogenic heat and, therefore, spent fuel management must take account of this. The heat output of fuel is also a consideration in terms of eventual disposal as there are likely to be temperature limits imposed in the waste acceptance criteria of a future GDF. Hitachi-GE proposes to store spent fuel for up to 140 years prior to disposing of it (see Chapter 6 - Strategic considerations for radioactive waste management).

376. For the GDA disposability assessment, Hitachi-GE has assumed that spent fuel will be over-packed for disposal, following interim storage. Robust disposal containers manufactured from either copper or steel are considered and each would contain 12 fuel assemblies from a UK ABWR based on the concept design for GDA. The container materials are chosen to be durable and corrosion-resistant, so that they provide long-term containment for the radionuclides within the spent fuel.

Non-aqueous liquid waste

377. Hitachi-GE has concluded that some non-aqueous liquids potentially contaminated with radioactivity will be generated in a UK ABWR. These will be generated from plant operations, such as maintaining pumps and hydraulic equipment. These types of waste may be in liquid form, or associated with materials such as rags, spill kit clean up waste and contaminated plant items. Such wastes are likely to be VLLW or LLW, or could be so lightly contaminated as to be out of scope of the regulations in terms of the definitions of radioactive waste.

378. Hitachi-GE has not quantified the specific nature of such arisings or the associated volumes, as these are particularly difficult to predict. However, it is argued based on developed reasoning, that the amounts will be low and that appropriate segregation, characterisation and treatment and disposal options are available for any such waste arisings. We agree that this is reasonable for GDA.

Comparison of arisings with those from comparable stations

379. Hitachi-GE has provided estimates for the annual arisings of LLW and ILW (Hitachi-GE, 2017c).

380. The total normalised arisings[3] of LLW (61.2 m^3) and ILW (32.1 m^3) exceed the European Utility Requirement objective of less than 50 m^3 per 1,000 MWe plant-year of operation (EUR, 2001). This objective has been used to compare solid waste arisings between different light water reactor designs in GDA[4], however this is not a legal limit and the figures in the footnote below show that the ABWR is comparable to other existing plants.

381. In response to RQ-ABWR-0355 'Discharges and waste arisings: comparison with other power stations', Hitachi-GE could not provide detailed comparative data for solid waste arisings (it only provided one data source for solid wastes). An Environment Agency study (Environment Agency,

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[3] Treated annual LLW (disposed or stored) 82.6 m3 (Table A2.3-1); ILW arisings 43.28 m3 (Tables A2.4-1 - A2.4-4) Figures taken from Hitachi-GE, 2017c. Normalised to 1,350 MWe (Hitachi-GE, 2017h).

[4] Note that in our earlier GDA assessments of the AP1000 design (a pressurised water reactor) the representative numbers were: 65.1 m^3 LLW per 1,000 MWe plant-year of operation; 36.6 m^3 ILW per 1,000 MWe plant-year of operation. For the EPR reactor design (a pressurised water reactor) the numbers were: 14.1 m^3 LLW and 26.6 m^3 per 1,000 MWe plant-year of operation.

2016a) also had difficulty in benchmarking the solid waste arisings based on internationally available literature sources for BWRs.

382. Radioactive Waste Management (RWM) has carried out a comparison of radionuclide inventories for the most active ILW stream and for spent fuel from PWR assessed to date as part of the UK ABWR disposability assessment (RWM Ltd, 2015)[5]. RWM concluded that radionuclides within the decommissioning waste streams are the main source of radioactivity arising in solid waste from the UK ABWR. Comparison with reported activities for similar wastes concluded that radionuclide activity in UK ABWR waste streams is comparable to that for Sizewell B (the UK's only operational PWR).

383. We note that it has been difficult to obtain extensive, relevant data on solid waste arisings to make comparisons. However, it seems reasonable to conclude that the UK ABWR design is not unusual in terms of quantities of solid wastes produced when compared to other modern light water reactor designs.

Minimising the quantity of solid waste

384. Having minimised the overall production of radioactive waste, the use of BAT to minimise the activity in gaseous and aqueous discharges tends to transfer activity to solid waste. This is in line with the principle of preferred use of 'concentrate and contain' over 'dilute and disperse' (GB Parliament, 2009a). There is little opportunity to reduce the activity of this waste, except by decay storage when the waste contains radionuclides with short half-lives. However, the quantity (mass and volume) of waste that needs finally disposing of can be reduced by using techniques such as waste sorting and segregation, compaction, incineration, removal of surface contamination, re-use and recycling.

385. Hitachi-GE has provided a summary in its 'Demonstration of BAT' submission of the techniques to enable minimisation of solid waste arisings. This demonstrates how specific claims and arguments are relevant to particular solid wastes. We note, in particular, that Claim 3 and specific arguments as part of Claim 1 are relevant to minimising solid waste; see Arguments: 1a, 1c, 1e, 1f, 1g, 1j in assessment report AR03 - Assessment of best available techniques (Environment Agency, 2017c). We agree that the arguments are valid and are supported by appropriate evidence, based on sampling of the evidence provided to us. Our view on each argument is provided in AR03.

386. Overall, we accept that the UK ABWR design uses BAT to minimise the quantity (mass/volume) of solid radioactive waste that will need to be disposed of.

Disposal of solid wastes

387. Hitachi-GE has sought to demonstrate that solid wastes generated by the UK ABWR design could be disposed of to appropriate routes based on currently established practice and national plans (Chapter 6).

388. We note, in particular, that Hitachi-GE claims in its 'Demonstration of BAT' submission (Claim 4 in AR03), that operators of a future UK ABWR would be able to select the 'optimal disposal routes for wastes transferred to other premises'. The arguments (4a – 4e in the 'Demonstration of BAT' submission) relate to providing waste management facilities, selecting the optimal disposal routes,

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[5] RWM (RWM Ltd, 2015) observes that for UK ABWR and PWRs the overall radionuclide inventories for waste and spent fuel will be broadly similar. This is proven by comparing radionuclide inventories for the most active ILW stream and for spent fuel from the reactor types that RWM has carried out as part of the UK ABWR disposability assessment. These types of waste contain the majority of the radioactivity that arises in solid form. The comparable inventories reflect similar design in terms of fuel types (that is similar enrichment and materials of fabrication).

agreement in principle for lower activity waste disposal routes, disposability assessment for higher activity wastes and compatibility with existing UK waste BAT studies.

389. Hitachi-GE has also performed optioneering studies to identify the best means by which to condition wastes for disposal. For ILW the proposal for GDA is to condition these wastes by cement encapsulation in stainless steel packages. Hitachi-GE outlines a range of spent fuel management options that would be available to any future site operator. However, for the purpose of GDA, it chose to use the KBS-3 disposal canister as RWM understands this package better. Before packaging the fuel for disposal, Hitachi-GE has assumed a dry cask storage system, similar to the Holtec system, for interim storage of spent fuel.

390. We conclude that Hitachi-GE has appropriately demonstrated that all solid waste arisings from the UK ABWR design would be disposable, in so far as this is possible at this time and to an extent that is in line with our expectations for GDA. We also consider that the proposed waste conditioning options are a suitable basis for assessment at the GDA stage.

391. Any future operators of a UK ABWR would need to demonstrate that waste arisings meet the acceptance criteria for available facilities, determine the optimal disposal routes and waste conditioning approaches at that time.

Management and disposability of higher activity waste and spent fuel

392. The ILW and spent fuel (if and when declared as waste) that would arise from a UK ABWR are referred to in the UK as higher activity waste (HAW). There is currently no disposal route in the UK for HAW. It is expected that HAW, along with spent fuel declared as waste, will eventually be disposed of to a geological disposal facility (GDF) (2014 White Paper, https://www.gov.uk/government/publications/implementing-geological-disposal). In the meantime, such wastes need to be managed in a way that adequately protects people and the environment, without compromising their disposability in a GDF.

393. A site operator would decide how to manage its wastes and condition them for disposal in line with the appropriate regulations at that time. Hitachi-GE argues in its 'BAT optioneering report' (Hitachi-GE, 2016c) that it has considered the viable options for higher activity wastes in the supporting optioneering for GDA. We are content that it has considered sensible options. We are also content that the options it has chosen demonstrate that the waste produced by the UK ABWR can be disposed of based on the current assessment context. We have, therefore, included an assessment finding to ensure a future operator demonstrates how solid waste management routes will be optimised.

- **Assessment Finding 10**: A future operator shall demonstrate optimised management and disposal of solid radioactive wastes from the UK ABWR, addressing in particular:
    - conditioning of higher activity waste arisings to ensure disposability
    - selection of disposal routes for wastes at the low activity waste/high activity waste boundary
    - management of spent nuclear fuel and any associated secondary wastes to ensure disposability
    - selection of disposal routes for low activity waste

394. We expect Hitachi-GE to 'obtain a view from the Nuclear Decommissioning Authority, as the UK authoritative source in providing such advice, on the disposability of such wastes and spent fuel' (Environment Agency, 2016b). We anticipate that the requesting party will also consider the advice in the case made for GDA and respond to it.

395. The GDA disposability assessment process comprises 3 main components: a review to confirm the waste and spent fuel properties; an assessment of the compatibility of the proposed waste packages with concepts for geological disposal of higher activity wastes and spent fuel; and

identification of the main outstanding uncertainties, and associated research and development needs relating to the future disposal of the wastes and spent fuel.

396. The overall objective of the disposability assessment process, previously called letter of compliance (LoC) assessment process (NDA, 2014), is to give confidence to all stakeholders that the future management and disposal of waste packages has been taken into account as an integral part of their development and manufacture. This is achieved by the site operator working to packaging standards and seeking input from RWM to explicitly demonstrate that the waste packages produced by a proposed packaging process will be compliant with the generic waste package specification and compatible with plans for transport to and emplacement in the planned future GDF.

397. Hitachi-GE has obtained disposability assessment advice from RWM and has responded to this advice. We have considered the submission to RWM, the resulting assessment report and the Hitachi-GE response to the advice.

398. RWM identified 3 key issues for ILW:

- Hitachi-GE's proposed use of 4 m^3 boxes for packaging and disposing of reactor pressure vessel (RPV) decommissioning wastes will need reconsidering because the dose rates will not meet transport regulations. RWM proposes using 3 m^3 boxes.
- Hitachi-GE has proposed disposing of wastes shortly after they arise. For some of the waste streams, this raises concerns about transport limits and operational limits at the GDF. These could be addressed by a period of decay storage for the relevant wastes.
- Control rods disposed of via an ILW route are challenging and will require a period of decay storage prior to Hitachi-GE's proposal for grout encapsulation in 3 m^3 boxes.

399. RWM has also considered a revised waste inventory, which Hitachi-GE submitted following the original submission for RWM's assessment. The latter was produced in response to a changed source term. This was prompted via interactions through the joint Regulatory Observation (RO-ABWR-0006) and the subsequent Regulatory Issue on source term aspects (RI-ABWR-0001, 'Definition and justification for the radioactive source terms in UK ABWR during normal operations').

400. We note that the numerous issues RWM identified are typical of pre-conceptual disposability advice and it is anticipated that such matters could be resolved during any formal disposability assessment process in the future. This is normal practice as the disposability assessment process is implemented formally with operators and, therefore, will be undertaken by a future operator.

401. RWM has also confirmed that the changed source term does not impact on the broad conclusions of the assessment report, as issued.

402. Hitachi-GE accept RWM's advice, which a future operator will need to consider further during the site-specific disposability assessment process in support of a conceptual stage disposability assessment. We note, however, that any future site operator will decide how to manage its wastes and condition them for disposal with appropriate regulatory oversight at that time.

403. We see no reason to believe that any of the ILW or spent fuel from a UK ABWR will not be disposable in a suitably designed and located GDF. We conclude that interactions through the course of the GDA process have identified a range of issues that will need to be addressed in the future programmes of any operators who might wish to pursue the options selected for GDA. We would expect to see more definitive assessments by any future operators to confirm how all of the ILW and spent fuel will be conditioned for disposal, that the selected conditioning methods represent the application of BAT at that time, and that in their conditioned forms the ILW and spent fuel will continue to be disposable.

Our overall conclusions on solid radioactive waste

404. Hitachi-GE has identified the projected solid wastes in terms of their category (HLW, ILW, LLW, VLLW), physico-chemical characteristics and proposed disposal routes. It has quantified the activity of the main individual radionuclides and overall groupings of radionuclides (for example, total beta), together with the likely mass and volume of the waste arisings.

405. Hitachi-GE has identified the solid waste in terms of broad characteristics, quantities and inventory. It has considered this against waste acceptance criteria for current waste routes and against possible disposal routes for the higher activity wastes and spent fuel for which there is currently no disposal route. We conclude that all wastes arising from the UK ABWR are likely to be disposable.

406. Hitachi-GE has described the conceptual design of waste facilities to manage and treat solid waste arisings. We conclude that appropriate waste treatment and disposal routes have been selected in this context. The proposed disposal routes are consistent with government policy and current UK practices.

407. For spent fuel, Hitachi-GE has identified dry storage in casks as a preferred option to make long-term storage before disposal easier. It describes a spent fuel interim store at a conceptual level for the UK ABWR design. This is broadly consistent with plans for managing existing light water reactor (LWR) fuel at Sizewell B, and is argued not to compromise eventual spent fuel disposability. We conclude that the proposed spent fuel management and disposal strategy is reasonable and consistent with the expectations of GDA (see Chapter 6 - Strategic considerations for radioactive waste management).

408. A future operator will need to consider how to ensure the performance of spent fuel during storage so as not to compromise eventual disposal. ONR regulates the storage of waste on nuclear licensed sites. We have engaged with ONR throughout our assessment and conclude that the arrangements proposed by Hitachi-GE for the UK ABWR at the GDA stage are suitable.

409. We conclude that:

- in its submissions, Hitachi-GE describes how solid radioactive waste and spent fuel will be generated, managed and disposed of throughout the facility’s life cycle at a level of detail in line with our expectations for GDA
- the quantities of solid waste produced by the UK ABWR are comparable to other light water reactor power stations across the world, and the UK ABWR design uses BAT to minimise the quantity (mass/volume) of solid radioactive waste that will need to be disposed of
- solid radioactive waste will be treated and conditioned using proven and recognised techniques, and potential disposal routes have been identified for all LLW solid wastes
- Hitachi-GE has provided information on the fuel composition and characteristics, the expected fuel burn up and the quantities of spent fuel that will arise, and described how spent fuel will be managed and disposed of throughout the life cycle of a UK ABWR at a level of detail in line with our expectations for GDA
- the proposed arrangements for interim management of higher activity solid wastes and spent fuel are unlikely to constrain their ultimate disposal (based on conceptual options developed at this time)
- Hitachi-GE has obtained a view from RWM, as the UK authoritative source in providing such advice, on the disposability of ILW and spent fuel, responded to RWM's advice and provided an opinion to the regulators

410. Our view is that all relevant aspects of the P&ID (Environment Agency, 2016b) in relation to solid radioactive waste have been addressed. The case Hitachi-GE has presented is in line with our expectations for GDA.

411. We have identified 2 Assessment Findings, as set out in the above paragraphs and at the beginning of this chapter.

More details of our assessment of solid radioactive waste are provided in our report [AR06 - Assessment of solid radioactive waste and spent fuel] (Environment Agency, 2017f).

12. Monitoring of discharges and disposals of radioactive waste

This chapter covers our assessment of Hitachi-GE's proposed techniques to measure and assess discharges of radioactive waste to the environment and the activity content of solid wastes.

This monitoring is necessary to:

- confirm that actual discharges are as predicted by the designer
- assess compliance with discharge limits
- provide good quality data for dose assessments
- characterise solid waste to enable its disposal by optimal routes

We conclude that the UK ABWR uses the best available techniques to monitor discharges and disposals of radioactive waste.

We have identified 5 Assessment Findings.

- **Assessment Finding 11**: A future operator shall address the 12 forward actions identified in the 'Approach to sampling and monitoring' submission - GA91-9901-0029-00001 Revision H, August 2017, (Hitachi-GE, 2017b).
- **Assessment Finding 12**: A future operator shall undertake tests to determine the particle concentration profile, and whether multi-nozzle probes are required, for the main stack sampling.
- **Assessment Finding 13**: A future operator shall demonstrate, prior to reactor commissioning, that the final configuration of the sampling lines and the layout and positioning of the monitoring room are optimised.
- **Assessment Finding 14**: A future operator shall demonstrate that, prior to procurement, the specific sampling and monitoring equipment for the determination of the discharges represents best available techniques and enables the EU recommended levels of detection to be met.
- **Assessment Finding 15**: A future operator shall demonstrate that the systems and equipment used for monitoring and sentencing solid waste represent best available techniques.

Table 12.1 - Summary of Hitachi-GE forward actions for a future operator (Assessment Finding 11).

Follow up actions identified by Hitachi-GE for a future operator
Identification of any additional gaseous discharge routes for monitoring (such as the service building and waste processing and storage facilities). **Only main stack of reactor building considered in GDA.**
Review of the main stack sampling design for a site-specific main stack design.
Determination of the main stack platform design.
Recording and reporting of the measurements. Including a recording system for sample collection time.
Ensuring all sampling and monitoring techniques achieve EU2004 detection limits.

Follow up actions identified by Hitachi-GE for a future operator
Ensuring appropriately accredited laboratories are selected for analysing samples, including MCERTS accreditation where applicable.
Selection of the specific sampling and monitoring equipment for the determination of the discharges. Including consideration of sampling flow rates. **Allowing for technological advances.**
For gaseous sampling the sampling period for each sample collector and the order of sampling will need to be confirmed.
The flow velocity and particle concentration profile will be determined to confirm the flow measurement and sampling point(s) location(s) within the stack.
Selection of the type of isokinetic probe for the main stack sampling, for example shrouded or unshrouded.
Define appropriate performance and leak checks to be undertaken after the maintenance and inspection of sampling probes to ensure the correct operation of the probe(s).
Determine the volume of the liquid sample required per unit of volume of discharge to enable analytical requirements to be met.

Please read below for a summary of our detailed assessment and links to further supporting documents.

Monitoring of gaseous waste

412. The monitoring of radioactive gaseous disposals are described in the Hitachi-GE's 'Approach to sampling and monitoring' submission, including considerations of best available techniques (BAT). This includes both the approach to in-process and final discharge monitoring.

413. Hitachi-GE states monitoring and sampling systems will be in place to enable activity concentrations to be determined for total noble gases (krypton-85 and argon-41 will not be measured specifically), particulates excluding iodines (cobalt-60, strontium-90, caesium-137) and total alpha (reported instead of individual alpha emitters), iodine-131, tritium and carbon-14. Calculations have been performed that indicate that the required values from the EU Commission recommendation 2004/2/Euratom (EU, 2004) for detection limits can be met using currently available systems.

414. The volumetric flow, required to determine the activity concentrations, will be measured continuously using an appropriate MCERTS[6] accredited technique. The exact configuration of the system will be determined during the commissioning phase following the appropriate ISO standards ISO 10780:1994 (ISO, 1994) and BS ISO 2889:2010, (BSi, 2010). A sample port on the main stack will also be provided for independent flow measurement. The access port will be consistent with the requirements of our regulatory guidance M1 (Environment Agency, 2017l) and with the provision of 3 standard waterproof sockets of single phase 110 V.

[6] MCERTS is the Environment Agency's Monitoring Certification Scheme. It provides the framework for businesses to meet our quality requirements.

415. There is 1 gaseous discharge monitoring point proposed on the main stack at a location that will allow for sufficient mixing of the air in the discharge and for the samples collected to be representative of the final discharge. Hitachi-GE is committed to isokinetic sampling consistent with the relevant standard (BSi, 2010). A sampling platform designed to comply with M1 (Environment Agency, 2017l) will be provided to allow workers to have safe access for inspecting and maintaining the sampling equipment, including to the independent port. The final design will depend on the equipment choice and will be made by a future operator.

416. One sampling line from the stack will feed 2 sampling systems. Having 2 sampling systems allows for contingency in the case of failure and for regulatory independent monitoring. The sampling line is being designed to meet the relevant standard, including considering lengths, bends, horizontal runs and temperature control. Modelling work has been undertaken on the penetration factors achievable for different configurations of the sampling line. This indicates that the requirements of BS ISO 2889:2010 can be met. Flexibility has been required as the final positioning of the monitoring room has not been determined. The modelling of penetration factors has been based on the discharge being high efficiency particulate air (HEPA) filtered, so the requirements of the standard (BS ISO 2889:2010) can be met. While this is the case for the off-gas system and HVAC, information provided indicated that filtration of the turbine gland steam system (TGS) and mechanical vacuum pump (MVP) lines was not intended and, therefore, they could potentially introduce particulates into the main stack and affect the discharge characteristics. We raised a Regulatory Query around this and Hitachi-GE has committed to installing HEPA filtration (appropriate to the conditions) into the TGS and MVP lines in its response.

417. The sampling systems themselves will be configured so the required nuclides are collected in an order that ensures the best sample is obtained. Particulates (for cobalt-60, strontium-90, caesium-137 and total alpha analysis) are collected first to minimise losses through plating out. Once particulates have been removed, the sample is passed through an appropriate iodine adsorber, before the sample is passed into the gas chamber for noble gases analysis. Tritium (H-3) and carbon-14 are collected on a different line.

418. It is good practice to return the sample downstream of the sample extraction point to prevent either double counting or dilution of the sample. However, Hitachi-GE has proposed the sample return line be upstream of the extraction point to save pipework and the amount of potentially contaminated material that needs to be disposed of at the end of the plant life. Given this saving and the fact that the impact of the returning gas would be negligible, due to the very small sample volume being diluted by the large stack flow rate, this approach has been accepted as BAT for the design.

419. We have assessed the information Hitachi-GE provided on the UK ABWR design for the determination of gaseous discharges against the requirements of our technical guidance notes M1 (Environment Agency, 2017l) and M11 (Environment Agency, 1999a) and relevant international and national standards (for example, BSi, 2010). The assessment also considered the commitment given to our Monitoring Certification scheme (MCERTS) for current in scope standards (Environment Agency, 2015 and 2011a) and flexibility to adopt future standards if nuclear facilities are within scope.

420. We have concluded that:

- BAT has been demonstrated for the UK ABWR gaseous effluent monitoring systems
- appropriate consideration has been given to the sampling line to ensure requirements for sampling can be met (through modelling penetration factors), final confirmation of the acceptability of the sampling line will be needed once the position of the monitoring room has been finalised
- representative samples will be taken
- appropriate measurement and analysis will be undertaken

- having the return of the sample to the discharge stack upstream of the sample extraction point will have a negligible effect on the discharge monitoring and is acceptable given the saving in pipework
- appropriate provision will be made to allow for independent regulatory verification of the gaseous monitoring and discharge reporting

421. There are a number of areas that a future operator will need to deal with. Hitachi-GE has identified these and they are shown in Table 12.1 at the start of this chapter. We have also recorded an Assessment Finding to ensure these are completed. The most significant ones are recorded as individual Assessment Findings:

- **Assessment Finding 11**: A future operator shall address the 12 forward actions identified in the 'Approach to sampling and monitoring' submission - GA91-9901-0029-00001 Revision H, August 2017.
- **Assessment Finding 12**: A future operator shall undertake tests to determine the particle concentration profile and whether multi-nozzle probes are required for the main stack sampling.
- **Assessment Finding 13**: A future operator shall demonstrate, prior to reactor commissioning, that the final configuration of the sampling lines and the layout and positioning of the monitoring room are optimised.
- **Assessment Finding 14**: A future operator shall demonstrate that, prior to procurement, the specific sampling and monitoring equipment for the determination of the discharges represents best available techniques and enables the EU recommended levels of detection to be met.

Monitoring aqueous wastes

422. The monitoring of radioactive liquid disposals are described in Hitachi-GE's 'Approach to sampling and monitoring' submission, including considerations of best available techniques (BAT). This includes both the approach to in-process and final discharge monitoring.

423. Hitachi-GE's submission states monitoring and sampling systems will be in place to enable activity concentrations to be determined for tritium and other radionuclides (excluding tritium) cobalt-60, strontium-90, caesium-137 and total alpha (reported instead of individual alpha emitters). Calculations have been made that indicate that the required values from the EU Commission recommendation 2004/2/Euratom (EU, 2004) for detection limits can be met using currently available systems. An exception to this is for alpha emitters, and Hitachi-GE indicate the limit of detection could be achieved using longer count times and these will be required of future operators, if this is the best way to achieve the required limit of detection.

424. For final discharge reporting there will be 1 sampling location on the final discharge line downstream of the aqueous waste treatment sub-systems. These treatment sub-systems have 2 storage tanks each and when a tank is full it is sealed from additional input and a sample collected once the re-circulation line has agitated that tank. This sample is analysed prior to discharge to confirm the activity is less than the permitted activity. This forms the in-process monitoring. Interlocks are in place to prevent simultaneous discharge and filling of the tank.

425. During discharge the final accountancy samples are taken via a flow proportional sampling system on the final discharge line. This gives an accurate record of what is actually discharged. Hitachi-GE is committed to using MCERTS accredited systems where available. At present pressurised systems are not covered, but are likely to be brought into scope in future. The samples will then be analysed by an accredited laboratory, including for MCERTS, where applicable. The discharge flow is also measured at this point using an appropriate MCERTS accredited technique.

426. To provide contingency in the event of equipment failure duplicates of both the flow proportional samplers and flow measurement apparatus will be provided. Providing these duplicate systems also allows for independent verification by the regulator or our representatives.

427. In addition to sample collection, a continuous radiation monitor is provided in the liquid discharge line. If the system detects a high radiation level, it activates an alarm and closes an isolation valve to stop discharge to the environment.

428. We have assessed the information Hitachi-GE provided on the UK ABWR design for the determination of liquid discharges against the requirements of our technical guidance note M12 (Environment Agency, 1999b). The assessment also considered the commitment given to our MCERTS (Monitoring Certification) scheme for current in scope standards (Environment Agency, 2015 and 2014a) and flexibility to adopt future standards if nuclear facilities are within scope.

429. We have concluded that:

- BAT has been demonstrated for the UK ABWR liquid effluent monitoring systems
- representative samples of the final discharge will be taken
- appropriate flow measurement will be undertaken
- appropriate analysis will be undertaken
- appropriate provision will be made to allow for independent regulatory verification of the liquid monitoring and discharge reporting

430. There are some more areas that a future operator will need to address. Hitachi-GE has identified these and they are itemised in Table 12.1 at the start of this chapter. We have also recorded an Assessment Finding to ensure these are completed. Assessment Finding 14 is also relevant to the monitoring of aqueous wastes:

- **Assessment Finding 11**: A future operator shall address the 12 forward actions identified in the 'Approach to sampling and monitoring' submission - GA91-9901-0029-00001 Revision H, August 2017, (Hitachi-GE, 2017b).
- **Assessment Finding 14**: A future operator shall demonstrate that, prior to procurement, the specific sampling and monitoring equipment for the determination of the discharges represents best available techniques and enables the EU recommended levels of detection to be met.

Monitoring solid wastes

431. The monitoring of solid waste disposals are outlined in Hitachi-GE's 'Approach to sampling and monitoring' submission, including considerations of best available techniques (BAT). More information is provided in Hitachi-GE's Radioactive solid waste monitoring requirements document (Hitachi-GE, 2016d).

432. The solid waste management system (SWMS) has only been developed at a concept level during GDA, so only an overview of the sampling of solid radioactive wastes has been provided. Hitachi-GE states that solid radioactive waste will be sampled and analysed at each stage to maintain traceability and assure SWMS performance. Prior to dispatch for final disposal, the sample is analysed in order to ensure compliance with the regulatory limit.

433. Information has been provided on the processes that have been considered for the complete waste cycle for the UK ABWR design with account of relevant guidance from the International Atomic Energy Authority (IAEA) and the nuclear industry code of practice (NICoP) (IAEA, 2007, IAEA, 2009 and NICoP, 2012, now Nuclear Industry Guide, 2017). This gives reassurance that the practices being developed should be appropriate. Examples of typical instruments and equipment have been cited to show proposals are based on current and achievable techniques. Hitachi-GE raises the issue that the UK analytical supply chain may have little experience with the mix of radionuclides in the ABWR waste types and, therefore, method development may be required. It is also recognised that future operators will need to work with the UK supply chain to identify where experienced characterisation capability exists or a development programme may be required.

434. As the monitoring systems for the waste handling facilities have only been developed to concept level these will need to be assessed at a later stage. The assessment will consider the

requirements of our P&ID (Environment Agency, 2016b) and the relevant guidance such as that referenced above.

435. Our preliminary conclusion is that the practices being developed appear appropriate for monitoring the final disposal of solid wastes, but a full assessment needs to be undertaken when more information has been provided.

436. We, therefore, have the following Assessment Finding:

- **Assessment Finding 15**: A future operator shall demonstrate that the systems and equipment used for monitoring and sentencing solid waste represent best available techniques.

Our overall conclusions on monitoring radioactive wastes

437. We conclude, in principle, subject to satisfactory closure of the assessment findings in relation to monitoring, that the UK ABWR uses the best available techniques to monitor discharges and disposals of radioactive waste.

438. We have identified 5 Assessment Findings, as set out in the above paragraphs and at the beginning of this chapter, including a table of follow up actions for the future operator.

You can find more details of our assessment of the monitoring of radioactive waste in our report [AR07 - Approach to sampling and monitoring] (Environment Agency, 2017g).

13. Impact of radioactive discharges

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

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

We conclude that, for the operation of a UK ABWR at any coastal site identified as suitable for new nuclear power stations (GB Parliament, 2011a) and with discharges at the annual limits specified in Chapters 10 and 11:

- the radiation dose to people will be below the UK constraint for any single new source of 300 microsieverts per year (µSv/y)
- doses to the public from discharges and direct radiation from a single ABWR are in the range of 14 to 24 µSv/y. Most of the dose is from gaseous discharges of carbon-14
- doses to the public from aqueous liquid discharges are very low, in the range of 0.000002 to 0.0002 µSv/y. This is because the discharge of radioactivity is very small, due to the recycling clean up and reuse of waste waters
- doses from direct radiation makes a contribution of between 0.3 and 0.9 µSv/y
- gaseous and aqueous discharges from the UK ABWR are unlikely to pose a risk to non-human species as dose rates are below the screening dose rate criterion of 10 micrograys per hour (µGy/h)
- Hitachi-GE has made an adequate assessment of the impact of the gaseous and aqueous liquid discharges to the environment
- A detailed site-specific assessment of the radiological impact from the UK ABWR will be required for any site where an application for a permit is made by a potential future operator. This should take into account all the reactors to be installed and any adjacent nuclear site

This chapter provides a summary of our detailed assessment and links to further supporting documents.

Summary of assessment of impact

439. We have assessed the information Hitachi-GE provided for the UK ABWR relating to the impact on members of the public and non-humans (plants and animals) as a result of the disposal of aqueous and gaseous radioactive waste by discharge to the environment.

440. We conclude that Hitachi-GE has made an adequate assessment of the impact of the gaseous and aqueous liquid discharges to the environment. The assessment assumes that the UK ABWR is located at a coastal location. The estimates of dose to members of the public are well below the UK constraint for any single new source of 300 µSv/y and also below the dose constraint proposed by Public Health England (HPA, 2009a) that recommends that the UK government selects a value for the constraint for members of the public from new nuclear power stations to be below 150 µSv/y.

441. 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. This conclusion will need to be confirmed by a detailed site-specific impact assessment that needs to be provided at site-specific permitting. The site-specific assessment will need to be based on the actual environmental characteristics of the proposed site to confirm that doses to members of the public from the UK ABWR at the proposed site will be as low as reasonably achievable (ALARA) and below relevant dose constraint and dose limits.

442. In its assessment of the impact on members of the public, Hitachi-GE carried out a three-stage assessment. This started with a simple and cautious assessment at stage 1, a more refined assessment at stage 2 and a detailed assessment at stage 3. For the stage 3 assessment, the Hitachi-GE estimate of doses was between 14 and 24 µSv/y. This dose was from the operation of a single UK ABWR. Discharges were assumed to be at the annual limits specified above. We were able to verify all stages of the assessment Hitachi-GE produced.

443. Our stage 3 assessment of the doses from the UK ABWR was between 14 and 24 µSv/y. Our assessment was similar to Hitachi-GE's, but with some different assumptions about the way the generic site was defined and the dispersion of radionuclides.

444. Hitachi-GE made an assessment of radiation dose rates to wildlife near an operating UK ABWR. It predicts the highest dose rates to be:

- 0.27 µGy/h to a terrestrial organism (bird, mammal and reptile)
- 0.0003 µGy/h to a marine organism (marine mammal)

445. We have also made our own assessment of radiation dose rates to wildlife near an operating UK ABWR. We predict the highest dose rates to be:

- 0.23 µGy/h to terrestrial organisms (reptile, mammals and birds)
- 0.00039 µGy/h to a marine organism (mammal)

446. These dose rates are well below the 10 µGy/h dose rate criterion that is appropriate to use at generic sites. We conclude that the gaseous and aqueous discharges from a UK ABWR at the generic site are unlikely to pose a risk to wildlife.

Verification of assessment of impact

447. Hitachi-GE has made an assessment of the impact of the discharges of radioactivity from the UK ABWR on the environment. We have reviewed its assessment in detail. Our review involved 3 main processes. Our first process was verifying the assessment Hitachi-GE provided. The verification aimed to reproduce the impacts Hitachi-GE assessed, adopting its model and input data to ensure there were no errors. Our second process was to validate the assessment that Hitachi-GE made to ensure it had adopted an appropriate approach and used best practice and guidance. Our third process was to carry out our own assessment of the impacts using best practice and recommended models and assumptions. These are summarised in Table 13.1 below. We also compared the outputs and approach from our own assessment with those of Hitachi-GE. We followed up any significant discrepancies with Hitachi-GE, where appropriate. These

processes helped us to be sure that the assessment of impacts on people and the environment were correct and valid.

Table 13.1 Summary of assessment outputs from the Hitachi-GE assessment of 1 UK ABWR and our verification for discharges at the proposed annual discharge limit

Assessment	Hitachi-GE calculated dose [(a)] (μSv/y)	Verification of Hitachi-GE assessment	Validation of Hitachi-GE assessment	Our calculated dose[(a)] (μSv/y)
Stage 1	144[(b)]	Vr	Vl	143
Stage 2	24.5[(b)]	Vr	Vl	26
Stage 3	14 to 24[(b),(c)]	Vr	Vl	14 to 24[(b),(c)]
Short duration release to atmosphere[(d)]	0.016 to 0.019	VC	N/A	0.002 to 0.004

[(a)] To groups most exposed to gaseous discharges. Doses to those most exposed to aqueous liquid discharges were very low in the range 0.000005 to 0.0002μSv/y

[(b)] Sum of doses to the groups most exposed to gaseous and aqueous discharges and direct radiation

[(c)] range of doses for 3 age groups, infants, children and adults. Highest dose to infants

[(d)] Units are μSv per short duration release

Vr – verified – able to reproduce its assessment

VC – validated by comparison between our assessment and Hitachi-GE's

Vl – able to validate the assessment assumptions and approach

Generic site concept

448. For GDA, we asked Hitachi-GE to define a 'generic site' to allow an assessment of the likely impact from a single unit of the UK ABWR reactor. The characteristics of the generic site should be appropriate to sites in England and Wales where nuclear power stations could be built. The generic site will define the 'envelope of applicability' of any statement of design acceptability (SoDA) issued.

449. We asked Hitachi-GE to identify the main factors affecting the doses received and take them into account when establishing the characteristics of the generic site. For example:

- weather and other factors affecting gaseous dispersion and deposition
- hydrographic and other factors affecting aqueous dispersion
- location of nearest food production, how close people might reasonably live to the site, the location of sensitive habitats and species
- food consumption rates and other human habits data

450. Hitachi-GE provided information on generic site characteristics. It derived its UK ABWR generic site characteristics assuming the UK ABWR will be located at a coastal site with a large amount of coastal water exchange (suitable for seawater cooling). It has chosen these characteristics to provide geographic representation for seawater cooling and represent data for a site where potentially the UK ABWR reactor might be located. We examined Hitachi-GE's generic site

description in some detail during our initial assessment (Environment Agency, 2014b) and concluded that the coastal nature of the generic site and the use of once-through direct cooling will limit the applicability of any future statement of design acceptability (SoDA) to a site with these characteristics.

451. The SoDA is limited to a site with parameters similar to those set out in the generic site description. Should a site be proposed for a UK ABWR that is not coastal, the permitting assessments will need to be based on the appropriate site characteristics.

452. At the detailed assessment stage we noted that the assumptions made in the initial version of the generic site description submission have remained unchanged throughout the issue of the various document revisions.

453. These assumptions represent a simplified representation of a generic UK site, which will have some implications for the impact assessment. However, we note that as a thorough site-specific assessment will be needed to support an application for an environmental permit, we conclude that some simplification is acceptable at the GDA stage.

454. Based on Hitachi-GE's 'Generic site description' submission we have noted the following:

- Hitachi-GE has selected a coastal site to represent the generic site. As government's National Policy Statement for Nuclear Generation (DECC, 2011a and 2011b) notes that all potential sites for new nuclear power stations are either located on the coast or on large estuaries, we are content that the selection of a coastal site is appropriate for GDA.
- Hitachi-GE has assumed that there is no standing water on the site. This could be considered to be unrealistic for the temperate climate of the UK, but surface water management is a site-specific aspect of design and we consider this to be appropriate for GDA.
- Hitachi-GE has assumed that there are no discharges to freshwaters. This has resulted in it excluding freshwater species from the non-human radiological assessment, but we will expect this to be considered at site-specific environmental permitting, if appropriate.

455. During the time between revisions to Hitachi-GE's submissions, a new 'Environmental Risk from Ionising Contaminants: Assessment and Management' (ERICA) tool was released, which resulted in a difference in the reference organisms considered for non-human radiological impact assessment in Revisions D to F of Hitachi-GE's 'Generic site description' submission. We agree that it is appropriate to use the latest version of the ERICA tool available at the time of each document issue

456. We conclude that the generic site description is appropriate for the purpose of the GDA .

You can find more details of our assessment of the generic site in our report [AR08 - Generic site description] (Environment Agency, 2017h).

Our requirements for the assessment of doses to people

457. We required Hitachi-GE to make an assessment of doses to the 'representative person'. This is the term for those people it is estimated will receive the highest dose overall from gaseous and aqueous liquid discharges and direct radiation. This assessment should use the generic site characteristics, together with agreed or expected levels of discharges, and suitable models to predict the behaviour and concentrations of radionuclides in the environment once they have been discharged. We require Hitachi-GE to allow for build up in the environment from discharges continuing for 60 years. Hitachi-GE adopted the PC-CREAM 08 model (Smith J.G. and Simmonds J.R., 2009) for the stage 3 assessment. PC-CREAM 08 is a software programme that calculates the concentrations of radionuclides in the environment from routine discharges.

458. Doses to members of the public are calculated taking account of the predicted levels of radionuclides in the environment over 60 years and the habits of members of the public near the site. The dose to the representative person is then compared with the dose constraint and dose limit. Doses to members of the public from direct radiation originating from within the site boundary

are regulated by ONR. However, for the purposes of comparing doses to the dose constraints, direct radiation has been estimated using data for direct radiation dose rates derived by Hitachi-GE using modelling and measurements. ONR will be making an assessment of Hitachi-GE's proposed direct radiation dose as part of its work in GDA.

459. The assessment approach is designed to make sure that provided the dose to the representative person is below these dose criteria, doses to the public near the site will also be less than the dose criteria. We may also consider doses from aqueous discharges or gaseous discharges separately. Where a separate assessment is made for different types of discharges, the term 'person most exposed to' is used. Doses from the separate assessments may be added together to provide an estimate of total dose from the reactor. However, this is likely to lead to an over-estimate of dose. This is because it is unlikely that any person would have both sets of habits that would lead to most exposure to various types of discharges at the same time. Therefore, the dose to the representative person is calculated using a method that makes realistic combinations of exposures and habits.

460. Hitachi-GE provided information on its assessment of doses to the public in its submission.

Hitachi-GE assessment approach

461. Hitachi-GE carried out a 3-staged approach to its assessment. The first 2 stages followed our initial radiological assessment methodology (Environment Agency, 2006), which allows a conservative assessment of doses to members of the public from discharges of gaseous and aqueous radioactive waste.

- Stage 1 is normally a conservative or bounding assessment that can be used as a screening assessment to identify if a more detailed dose assessment is required. Hitachi-GE used our published dose per unit release factors given in our initial radiological assessment methodology. For gaseous radioactive waste discharges, Hitachi-GE assumed an effective release height at ground level for the stage 1 assessment, which is likely to be the worst case. For aqueous radioactive waste, it was assumed discharges were made into local coastal waters, which then mix with water from elsewhere along the coast at a rate described as the volumetric exchange. The volumetric exchange rate used was 100 m^3/s, which is the conservative value recommended in our initial radiological assessment methodology.
- Stage 2 is a more refined assessment using more realistic main parameters such as stack height and dispersion factors. Hitachi-GE used our published dose per unit release factors in a more realistic way. For gaseous discharges, the effective release height was assumed to be 20 m, which Hitachi-GE considers to be more realistic. For aqueous discharges, the volumetric exchange rate along the coast was unchanged from stage 1 at 100 m^3/s. This is a very conservative value, and typical of a modest estuary. Other coastal locations show exchange rates of up to 3,000 m^3/s. The exchange rate around Wylfa is 1,200 m^3/s, which is where UK ABWRs might be located.

462. For both stage 1 and 2 the methods used calculate doses to the most exposed members of the public for gaseous and aqueous radioactive waste discharges. Doses to the most exposed members of the public were calculated for 4 age groups (infant, child and adult and fetus) for each radionuclide in the discharge. The doses to the age group that resulted in the highest dose to the most exposed member of the public for each radionuclide have been used to calculate the total dose to the most exposed members of the public.

463. Hitachi-GE also estimated doses from direct radiation from the UK ABWR in order to predict the dose to the representative person.

464. Stage 3 is a more detailed assessment and is usually carried out where stage 2 outputs are above dose criteria. A stage 3 assessment may also be carried out where additional assurances or more detail is needed about predicted doses.

465. Hitachi-GE carried out stage 3 of the assessment using the PC-CREAM 08 model assessment system. The assessment assumed continuous uniform releases for 60 years at the maximum annual discharge levels for both aqueous and gaseous radioactive waste. The assessment assumed an effective release height of 19 m for gaseous releases, based on a physical stack height of 57m. For aqueous discharges, the volumetric exchange rate along the coast was 1,270 m^3/s. This is a relatively high dispersion rate relative to other sites and so will tend to increase the dispersion and dilution of radionuclides compared with other nuclear sites.

466. The stage 3 assessment takes into account the potential for exposure of members of the public by a combination of internal and external exposures (for example, ingestion or direct radiation from the ground). For example, Hitachi-GE has assumed that members of the local resident family may also consume seafood at an average rate, and members of the fisherman family may consume food grown on the land, 50% of which is locally sourced. This provides a realistic assessment of dose to the representative person for the UK ABWR.

467. We consider the approach and assumptions Hitachi-GE made in its dose assessment to be reasonable.

Hitachi-GE assessment results

468. Table 13.2 shows the doses Hitachi-GE predicted.

Table 13.2: Hitachi-GE predicted doses for the UK ABWR design for discharges at the proposed annual discharge limit

Pathway	Doses to the public (µSv/y)		
	Stage 1	Stage 2	Stage 3
Aqueous discharges	0.0035	0.00027	0.000002 to 0.00001
Gaseous discharges	143	23.6	12.7 to 23.5
Direct radiation	0.9	0.9	0.3 to 0.9
Total dose	144	24.5	14 to 24
Short duration release to atmosphere [b, c]	N/A	N/A	0.016 to 0.019[a]

[a] Assuming discharges are enhanced from fuel pin failure over 24 hours

[b] Units are µSv

[c] The enhanced discharges of short duration releases are noble gases

469. Hitachi-GE's stage 3 assessment resulted in estimated doses to the representative person of the public of 24 µSv/y to an infant (Table 13.2). Doses to other age groups were 15 µSv/y to a child and 14 µSv/y to an adult.

470. The highest contribution to dose was from consuming carbon-14 in milk and milk products, resulting from discharges to atmosphere.

471. From time to time, processes on site may result in additional discharges to atmosphere. These include de-fuelling and coolant purges. The discharges can range from 30 minutes to several hours. Hitachi-GE has made an assessment of a short duration release. Assuming enhanced discharges due to fuel pin failure, 1 month's discharge is released over 24 hours. These resulted in estimated doses from a UK ABWR to the representative person of the public of 0.02 µSv to an infant, an adult or a child.

472. We conclude that all the doses Hitachi-GE assessed are below the dose constraint for members of the public of 300 μSv/y and the dose constraint recommended by Public Health England (PHE) for new build of 150 μSv/y.

Our verification of Hitachi-GE assessment results

473. We were able to repeat all 3 stages of the Hitachi-GE dose assessment.

474. We have also carried out our own dose assessment, assuming discharges are made at the permitted discharges. For this, we used the PC-CREAM 08 model and standard approach. We adopted a slightly different generic site, which took into account coastal situations based on an estuary where seawater cooling may not be possible.

475. Our stage 3 assessment showed the highest estimated dose from a UK ABWR is 24 μSv/y to the representative person, who is most exposed to gaseous discharges (Table 13.3) and received doses from direct radiation and aqueous discharges.

476. The highest doses are from gaseous discharges and the highest contribution was from carbon-14 in milk and milk products.

Table 13.3 Summary of our independent assessment of doses to the representative person from the UK ABWR design in the 3 stages of the assessment at the proposed maximum annual discharge limit

Pathway	Doses to the public (μSv/y)		
	Stage 1	Stage 2	Stage 3 [(a)]
Aqueous discharges	0.0035	0.0027	0.000002
Gaseous discharges	143	26	24.1
Direct radiation	N/A	N/A	0.3
Total dose	144	26	24.4

[(a)] Age group receiving the highest dose is infant

Doses to people - collective dose

477. Collective dose is sometimes used as a measure of the radiation detriment to a population. It is the sum of all the doses received by the members of a population over a specified period of time. Collective doses are assessed in man-sieverts (manSv).

478. Hitachi-GE has provided information on collective dose. It has estimated collective dose to UK, Europe and world populations per year of discharge, for up to 500 years using the PC-CREAM 08 model.

479. Table 13.4 shows the results of Hitachi-GE's collective dose assessment.

Table 13.4 Collective doses estimated by Hitachi-GE per year of discharge from UK ABWR for discharges at the proposed annual discharge limits

Population	Collective dose (manSv per year of discharge)	Per person dose (nano-Sv/y)
UK	0.43	7.2

Europe-12	2.6	7.2
Europe-25	2.9	6.3
World	29.9	3.0

Note - Europe-12 and Europe-25 relate to the number of member states of the European Community considered in the collective dose calculation.

480. Hitachi-GE considers that the collective dose to all populations is dominated by releases of carbon-14 in gaseous radioactive waste, in the range 0.4 to 29.9 manSv per year of discharge.

481. Collective doses from aqueous liquid discharges presented by Hitachi-GE are very low, ranging from 0.0000004 to 0.00003 manSv per year of discharge. This is because the radioactivity levels in these discharges are very low.

482. Collective doses were converted to average 'per person' annual doses.

483. We have also carried out our own calculations of collective dose. We did this for the UK, European and world populations, for up to 500 years, assuming discharges are made at the proposed annual discharge limits for aqueous and gaseous radioactive waste. We used the PC-CREAM 08 software to estimate collective dose. Our results are set out in Table 13.5 below.

Table 13.5 Our estimate of collective doses per year of discharge from UK ABWR for discharges at the proposed annual discharge limits

Population	Collective dose (manSv per year of discharge)	Per person dose (nano-Sv/y)
UK	0.8	14
Europe-25	4.5	9.8
World	30.0	3.0

484. Comparing our assessment of collective dose and the assessment Hitachi-GE carried out shows that the results are similar. Our assessment of collective dose similarly showed collective dose to be dominated by gaseous discharges containing carbon-14. Discharges of aqueous radioactive waste are very small and give very small collective doses.

Non-human species

485. We need to know the likely impact of the proposed discharges on non-human species to show that they will be adequately protected and that relevant conservation legislation will be complied with. In a similar way to the assessment of doses to members of the public, models of the behaviour and transfer of radionuclides within ecosystems are used to predict environmental concentrations, from which the radiation doses to reference organisms can be estimated. These doses can then be compared to dose rate criteria to assess the risk to plants and animals. We have adopted a dose criterion of 40 µGy/h as the dose rate below which wildlife is adequately protected. This dose criteria applies to all radiological discharges affecting a protected site. Because non-human species may be affected by radioactive discharges from more than 1 site, we also use a screening value of 10 µGy/h when considering the impact from a single source, such as in GDA.

486. Hitachi-GE provided information in its submission on assessment of doses to non-human species ('Summary of the generic environmental permit applications' chapter on 'Prospective dose modelling', Section 14). Its approach to assessing the radiological impact on non-human species is as follows:

- Hitachi-GE has assumed that gaseous and aqueous discharges are made at the proposed limits.
- Hitachi-GE has used PC-CREAM 08 (Smith J.G. and Simmonds J.R., 2009) to derive activity concentrations of radionuclides in the environment after 60 years of operation of a UK ABWR unit.
- In its assessment, Hitachi-GE has used the Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) integrated approach (Beresford et al., 2007), which is the accepted practice within Europe. This approach aims to ensure that decisions on environmental issues give appropriate weight to the environmental exposure, effects and risks from ionising radiation, with emphasis on ensuring the structure and function of ecosystems.
- To carry out the assessment, Hitachi-GE used the ERICA tool (Brown et al., 2016), which is a software programme that calculates the radiation dose rate that reference organisms are 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. Hitachi-GE assumes that the gaseous and aqueous discharges will affect terrestrial and marine environments respectively, and have undertaken assessments of the terrestrial and marine reference organisms in the ERICA tool. Hitachi-GE has assumed that no discharges are made to freshwater environments, and has not undertaken an assessment of freshwater reference organisms.
- The ERICA tool does not enable the user to assess the impact of noble gas discharges on non-human species. Therefore, to assess the impact of noble gases to non-human species, Hitachi-GE has used the 'Ar-Kr-Xe dose calculator' tool (Vives i Batlle et al., 2015). This spreadsheet-based tool uses a reference organism approach to calculate dose rates to non-human species in the terrestrial environment from noble gases. The reference organisms in the ERICA tool and the 'Ar-Kr-Xe dose calculator' tool are the same, and, therefore, the dose rates from each tool can be added together to provide an overall dose rate to reference organisms from gaseous discharges.

487. The ERICA integrated approach has a default screening dose rate criterion for all ecosystems of 10 µGy/h. The ERICA integrated approach takes a tiered approach that allows progressively more detailed assessment depending on the magnitude of the dose rates calculated:

- Tier 1 is simple and conservative – it requires a minimal amount of input data, the user can select from a range of radionuclides and calculate the dose rate for the most sensitive combination of reference organisms.
- Tier 2 is more specific and less conservative – the user defines radionuclides of interest and edits transfer parameters. Dose rates are calculated for each reference organism individually.
- Tier 3 is very specific and detailed – used in complex and unique situations and involving a probabilistic risk assessment approach. A tier 3 assessment requires consideration of biological effects data.

488. Results of the assessment carried out by Hitachi-GE:

- Hitachi-GE carried out its assessments at tier 2 and considered the risk to terrestrial reference organisms from gaseous discharges, and marine reference organisms from aqueous discharges, assuming waste was discharged at proposed limits for 60 years of operation.
- The results of its assessment of the impact of gaseous discharges identified that the most exposed reference organisms were birds, large and small mammals and reptiles, which received a dose rate of 6.1 µGy/h. This assessment conservatively assumed that the gaseous discharges are released at ground level. When Hitachi-GE assumed that gaseous discharges were released from a realistic physical stack height of 57 m (effective stack height of 19m), the most exposed reference organisms (bird, large mammal, small mammal and reptile) were exposed to a lower dose rate of 0.27 µGy/h.

- The results of its assessment of the impact of aqueous discharges identified that the most exposed reference organism were mammals with a dose rate of 0.0003 µGy/h.
- The assessments undertaken by Hitachi-GE show that the dose rates to non-human species from gaseous and aqueous discharges are below the screening dose rate criterion of 10 µGy/h. In addition, when gaseous discharges were assumed to be released from a realistic stack height, the assessments show that for each reference organism the probability that the UK ABWR discharges would result in dose rates that exceed the 10 µGy/h screening dose criterion was less than 1%.

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

- A validation exercise using the ERICA tool to satisfy ourselves that the results of the assessments undertaken by Hitachi-GE could be reproduced.
- An independent assessment using the ERICA tool and the 'Ar-Kr-Xe dose calculator' tool to determine dose rates using discharge data Hitachi-GE provided, and predicted activity concentrations an independent contractor modelled for us. For this assessment, we assumed that gaseous discharges were released at proposed limits and from a realistic stack height.

490. When we used the same input data and parameters, we were able to reproduce the results of the assessments that Hitachi-GE carried out using the ERICA and the 'Ar-Kr-Xe dose calculator' tools.

491. Our independent assessment of gaseous discharges identified that the most exposed reference organisms were birds, reptiles, large mammals and small burrowing mammals, and that they would receive a dose rate of 0.23 µGy/h.

492. Our independent assessment of aqueous discharges identified that the most exposed reference organisms were mammals and that they would receive a dose rate of 0.00039 µGy/h.

Comparison with standards

Source dose constraint

493. There is a dose constraint in the Environmental Permitting Regulations 2016 (EPR16) (GB Parliament 2016b) for the maximum dose to people that may result from discharges from a new single source (for example, a new power station). The constraint is 300 µSv/y and it applies to the dose from proposed discharges and direct radiation.

494. As set out above, our independent assessment shows that, for the UK ABWR, the sum of doses to the representative person from the maximum expected discharges and direct radiation is 14 to 24 µSv/y and is below the source dose constraint.

495. We conclude that the sum of doses to the representative person is below the source dose constraint.

Site dose constraint

496. There is also a dose constraint in EPR16 (GB Parliament 2016b) for the maximum dose to people that may result from discharges from a site as a whole. The dose constraint is 500 µSv/y and it applies to the total dose from the discharges, in this case direct radiation is not included, from all sources at a single location, including discharges from any immediately adjacent sites that share a boundary.

497. We consider, in the light of our assessment, that the highest total dose from a reactor is estimated to be 14 to 24 µSv/y. Although 2 or 3 UK ABWR reactors may be installed in a single power station, it is very unlikely that doses at the site where several UK ABWRs are installed next to an existing nuclear site will exceed the site dose constraint of 500 µSv/y.

We conclude that site dose should be re-assessed at site-specific permitting. This should take into account all the reactors installed and any adjacent nuclear site.

Dose limit

498. Schedule 23 of the Environmental Permitting Regulations 2016 (GB Parliament, 2016b) specifies dose limits to members of the public from the impact arising from all artificial sources of radioactivity including past discharges, but excluding medical exposure and exposure to radiation from accidents. The dose limit (effective dose) is 1.0 mSv/year, also specified in Article 13 of the EU Basic Safety Standards Directive (Council Directive 96/29/Euratom) (EU, 1996).

499. The UK is currently implementing the revised Basic Safety Standards Directive (BSSD-13), (EU, 2013). The BSSD-13 sets out renewed and revised standards for protection against the dangers arising from exposure to ionising radiation. In the BSSD-13, the dose limit for the public is set out in Article 12 and remains at 1.0 mSv/y. The BSSD-13 will be transposed into future national legislation. The Department for Business, Energy and Industrial Strategy, (BEIS), is responsible for coordinating and reporting the UK transposition to the European Commission and the Member States.

500. The highest total dose from a reactor at the proposed discharge limits is estimated to be 14 to 24 µSv/y. Although 2 or 3 UK ABWR reactors may be installed in a single power station, it is very unlikely that doses at the site where several ABWRs are installed next to an existing nuclear site will exceed the dose limit of 1,000 µSv/y. For example at Wylfa, in recent years doses to the public from the existing Magnox power station have ranged from 5 to 11 µSv/y.

501. Comparison against the dose limit can only be assessed at site-specific permitting when contributions from all sources of radiation can be included.

Effect of short-term releases

502. The assessment of annual doses assumes that discharges are evenly spread throughout the year. However, some discharges may occur intermittently and over a short period. The dose per unit discharge for short-term discharges can be higher than that for continuous discharges, depending on factors such as the time of year, the prevailing weather conditions and the state of nearby pasture or crops. An assessment has been made of potential short duration (up to 24 hours) releases. Hitachi-GE's assessment of short duration releases indicated that the radionuclides expected to be released over a short duration would be noble gases arising from fuel pin damage. The doses from short duration releases are 0.02 µSv per event. Our assessment of the effect of short duration releases was similar. In the event of a short-term release, this additional dose would not cause the source constraint, site constraint or dose limit to be exceeded.

Collective doses

503. The collective dose from the UK ABWR ranges from 0.4 to 30 manSv per year of discharges. There are no limits or constraints for collective dose. However, the International Atomic Energy Agency (IAEA) has set a level for collective doses of less than 1 manSv per year of discharge below which it is unlikely to be appropriate to undertake detailed option studies.

504. Public Health England (PHE) provided additional guidance on assessing how important the collective doses are. It advises calculating an average dose to members of the population (per person doses). PHE further advised that if the average per person doses for a population group are only a few nano-sieverts (nSv) per year, we can consider them to be less important. If the per person doses increase above this level, we may need to look more carefully at the discharge options. Dose per person were derived from the collective doses calculated in the independent assessment and are in the range of 3 to 14 nSv/y, which is very low.

Background dose rates from natural sources of radioactivity

505. The expected doses to the public can be compared with background dose rate from natural sources of radioactivity. Natural background dose rates include cosmic rays, doses from naturally occurring radionuclides in foods, doses from rocks and soil and doses from radon gas. Natural background dose rates are affected by underlying geology which varies across the UK. Levels of radon gas also vary and make a big contribution to doses in parts of the UK. Natural dose rates range from 1.5 mSv/y to 8 mSv/y across the UK. The UK average is 2.2 mSv/y.

Non-human species

506. Our independent assessments also showed that for each reference organism the probability that the UK ABWR discharges would result in dose rates exceeding the 10 µGy/h screening dose rate was less than 1%. This probability is calculated within the ERICA tool and is part of the tier 2 assessment.

507. A summary of the results of a comparison of the Hitachi-GE assessment with our assessment is set out in Table 13.6 below.

Table 13.6 - Comparison of Hitachi-GE's assessment results with independent assessment results

Assessment types	Data source	Hitachi-GE results	Our results
Terrestrial assessment from gaseous discharges			
ERICA Tier 2	Hitachi-GE (assuming ground level release)	Highest dose rate to any reference organism is 6.09 µGy/h.	Same as Hitachi-GE results.
	Hitachi-GE (assuming release from stack)	Highest dose rate to any reference organism is 0.27 µGy/h.	Same as Hitachi-GE results.
	Independent (assuming release from stack)		Highest dose rate to any reference organism is 0.23 µGy/h.
Ar-Kr-Xe dose calculator	Hitachi-GE	Highest dose rate to any reference organisms is 0.0064 µGy/h.	Same as Hitachi-GE results.
	Independent		Highest dose rate to any reference organism is 0.00024 µGy/h.
Total	Hitachi-GE (assuming ground level release)	Highest dose rate to any reference organism is 6.1 µGy/h.	Same as Hitachi-GE results.
	Independent (assuming release from stack)		Highest dose rate to any reference organism is 0.23 µGy/h.
Marine assessment from aqueous discharges			
ERICA Tier 2	Hitachi-GE	Highest dose rate to any reference organism is 0.0003 µGy/h.	Same as Hitachi-GE results.
	Independent		Highest dose rate to any reference organism is 0.00039 µGy/h.

508. There are some differences between the results of Hitachi-GE’s assessments and our independent assessment. Our independent terrestrial assessment of gaseous discharges from UK ABWR showed that non-human biota would be exposed to lower dose rates than those calculated by Hitachi-GE. This variability is due to differences in the 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 Technical Specialist Contractor (TSC) calculated dose rates at a greater distance of 300 m from the stack. Our independent marine assessment of aqueous liquid discharges from 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 marine dispersion modelling parameters used to calculate concentrations of radionuclides in the sea from UK ABWR discharges. Our TSC used less dispersive parameters resulting in higher concentrations of radionuclides in the marine environment and slightly higher dose rates to marine reference organisms.

509. We consider the assessment that Hitachi-GE carried out to be conservative and reasonable at the GDA stage. We also consider that Hitachi-GE has used an appropriate approach to assessing the radiological impact of the UK ABWR on non-human species. The results of the assessment Hitachi-GE carried out and our independent assessment show that dose rates to non-human species will not exceed the screening dose rate criterion at the generic site.

510. We conclude that at the GDA stage we consider that the gaseous and aqueous discharges from UK ABWR are unlikely to pose a risk to non-human species. We consider that the assessment is suitably conservative at this stage of the process. We recognise that a detailed site-specific assessment of the radiological impact from the UK ABWR will be required for any site where a UK ABWR is proposed.

Our overall conclusions on the impact of radioactive discharges

511. We conclude that, for the operation of a UK ABWR at any coastal site identified as suitable for new nuclear power stations (GB Parliament, 2011a) and with discharges at the annual limits specified in Chapters 10 and 11:

- the radiation dose to people will be below the UK constraint for any single new source of 300 microsieverts per year (μSv/y)
- doses to the public from discharges and direct radiation from a single ABWR are in the range of 14 to 24 μSv/y. Most of the dose is from gaseous discharges of carbon-14
- doses to the public from aqueous liquid discharges are very low, in the range of 0.000002 to 0.0002 μSv/y. This is because the discharge of radioactivity is very small, due to the recycling clean up and reuse of waste waters
- doses from direct radiation makes a contribution of between 0.3 and 0.9 μSv/y
- gaseous and aqueous discharges from the UK ABWR are unlikely to pose a risk to non-human species as dose rates are below the screening dose rate criterion of 10 micrograys per hour (μGy/h).
- Hitachi-GE has made an adequate assessment of the impact of the gaseous and aqueous liquid discharges to the environment
- A detailed site-specific assessment of the radiological impact from the UK ABWR will be required for any site where an application for a permit is made by a potential future operator. This should take into account all the reactors to be installed and any adjacent nuclear site

512. Our independent assessment considered a more restrictive coastal environment than the one Hitachi-GE used. Our assessment shows that the low levels of radioactivity in aqueous liquid discharges from the UK ABWR leads to low doses to the public in an environment with restricted dispersion.

You can find more details of our assessment of the impact of radioactive discharges in our reports [AR09 - Assessment of radiological impacts on members of the public and AR10 - Assessment of radiological impacts on non-human species] (Environment Agency, 2017i and 2017j).

14. Our overall conclusion on radioactive substances permitting

We conclude that, subject to the Assessment Findings identified in Chapters 5 to 13, the design is acceptable for permitting for the disposal of radioactive waste at any coastal site listed in NPS EN-6 (GB Parliament, 2011a). We do not believe that any of the Assessment Findings are so fundamental that they are unlikely to be resolved satisfactorily before or during site-specific permitting.

We have assessed the UK ABWR design and set out our findings in Chapters 5 to 13. Our conclusions for these chapters are summarised below:

- **Quality management systems**: Hitachi-GE has a quality management system (QMS) and has developed specific management system arrangements for the GDA project. We are satisfied that Hitachi-GE has developed and implemented a suitable management system for the GDA project**.**
- **Best available techniques (BAT)**: Hitachi-GE has recognised the relevant principles of optimisation and applied these in presenting the GDA case. Its approach has also been guided by considering standard environmental permit conditions and our GDA guidance. Hitachi-GE has also carried out a number of optioneering exercises to identify optimal approaches to the UK ABWR for GDA purposes. Overall, we conclude that Hitachi-GE has followed an appropriate process for identifying BAT in the design of the UK ABWR, to prevent and minimise the creation of radioactive waste, and to minimise the overall impact of discharges to the environment.
- **Gaseous and aqueous radioactive wastes**: We conclude that gaseous and aqueous discharges arising from all modes of normal operation have been considered, including discharges from any events that are expected to occur during the operational life of the UK ABWR. We conclude that all appropriate radionuclides have been considered, and that the selection of significant radionuclides is appropriate. We conclude that the proposed discharge limits are of the appropriate order, and that discharges from the UK ABWR should not exceed those of comparable power stations across the world.
- **Solid radioactive wastes**: We conclude that optimal potential disposal routes have been identified for all lower activity solid wastes, and that all higher activity solid wastes and spent fuel are likely to meet disposability criteria for the proposed national geological disposal facility. We agree the proposed arrangements for interim management of higher activity solid wastes and spent fuel are unlikely to affect their ultimate disposal. We conclude that the quantities of solid waste produced by a UK ABWR are comparable to other light water reactor power stations across the world.
- **Monitoring discharges and disposals**: We conclude that the UK ABWR uses the best available techniques to monitor discharges, but require further detail on monitoring for the disposals of solid radioactive waste following the solid radioactive waste treatment system design at site-specific stage.
- **Impact of radiological discharges**: Doses to the public from discharges and radiation from a single ABWR are in the range of 14 to 24 μSv/y. Doses to the public from aqueous liquid discharges are very low, because the discharge of radioactivity is very small, due to the recycling clean up and reuse of waste waters. Most of the dose is from gaseous discharges, from carbon-14. All doses are below the source dose constraint of 300 μSv/y. The radiological impacts are also below the dose criterion for wildlife of 10 μGy h^{-1}.

Overall, we conclude that, subject to the Assessment Findings identified in Chapters 5 to 13, the design is acceptable for permitting for the disposal of radioactive waste at any coastal site listed in NPS EN-6. We do not believe that any of the Assessment Findings are so fundamental that they are unlikely to be resolved satisfactorily before or during site-specific permitting.

15. Water abstraction

This chapter covers our assessment of water use and abstraction.

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

We conclude that:

- an abstraction licence is not likely to be required for the cooling water as the proposals are for abstracting water from the open sea only
- the screening on the cooling water abstraction intakes to minimise fish ingress and injury and meet the requirements of the Eels (England and Wales) Regulations 2009 (GB Parliament, 2009b) is a site-specific issue and can only be determined once the local environmental conditions are known

Please read below for a summary of our detailed assessment and links to further supporting documents.

Cooling water

514. Hitachi-GE states that seawater will be used for once-through cooling in the main steam condenser and for cooling other reactor and turbine components ('Other environmental regulations' submission). The seawater cooling system can be divided into 3 systems: the circulating water system (CW), turbine building service water system (TSW) and the reactor building service water system (RSW).

515. Hitachi-GE states that the cooling water flow rate is based on a 12 ^oC increase in the temperature of the intake water at the point of discharge back into the sea. Under normal operation the flow rate for the CW is 184,000 m^3/hour, the flow rate for the TSW is 7,400 m^3/hour and the flow rate for the RSW is 10,800 m^3/hour. The total annual volume of seawater required will be approximately 1.8 billion m^3/year.

516. Abstracting water from the open sea does not require an abstraction licence unless the particular location of the abstraction means that it falls within the definition of inland waters. The generic site for the purposes of GDA is considered a coastal location and, therefore, an abstraction licence is not required. The location of abstraction points for each specific site will need to be assessed individually to determine whether an abstraction licence is required.

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

518. Hitachi-GE in its 'Other environmental regulations' submission has described the different screens (drum, travelling band, bar) that could be used along with the other types of barriers for capturing and returning fish and eels back to the sea. The location of cooling water abstraction intakes and their design and screening options to minimise fish ingress and injury and meet the requirements of the Eels (England and Wales) Regulations 2009 (GB Parliament, 2009b) depends on the local environment and can only be determined at the site-specific stage.

Other water use

519. Hitachi-GE states that the GDA is based on the assumption that the local water company will supply all fresh water requirements and that freshwater abstraction and an abstraction licence will not be required.

520. Hitachi-GE states in its submission that fresh water will be used in different ways:

- for drinking, washing and showering
- within the process
- to supply the demineraliser plant
- to supply fire water

521. The domestic fresh water requirements will depend on the number of people present and will be addressed at the site-specific stage. Hitachi-GE states that the normal amount of fresh water used within the process will be 99.2 m^3/day, increasing to 819.2 m^3/day when intermittent systems are operating.

522. Fresh water is also needed by the purified water treatment facility (PWTF). This is used for reactor water, auxiliary boiler water and boronated water in the standby liquid control system. Hitachi-GE states that the PWTF is expected to use 900 m^3/day when operating at a maximum rate.

523. The UK ABWR will also have a back-up water supply of 10,000 m^3. Fire water supply is 1,000 m^3.

Our overall conclusions on water abstraction

524. We conclude that:

- an abstraction licence is not likely to be required for cooling water where the abstraction is from the open sea
- the screening on the cooling water abstraction intakes to minimise fish ingress and injury and meet the requirements of the Eels (England and Wales) Regulations 2009 (GB Parliament, 2009b) is a site-specific issue and can only be determined once the local environmental conditions are known

You can find more details of our assessment of the impact of radioactive discharges in our report [AR11 - Assessment of other environmental regulations] (Environment Agency, 2017k).

16. Discharges to surface waters and groundwater

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

Non-radioactive contaminants include the heat transferred to the cooling water, as well as process and other chemicals. We assess the environmental impact of the discharges by comparing the predicted concentrations of contaminants in the receiving waters against relevant environmental standards.

We conclude that:

- subject to the relevant Assessment Findings set out below, the UK ABWR design is likely to be acceptable for permitting for the discharge of non-radioactive substances to surface waters at any coastal site listed in NPS EN-6 (GB Parliament, 2011a)
- a permit for discharges to groundwater will not be required since there are no proposals for intentional discharges to groundwater (whether direct or indirect), and the design includes all necessary and reasonable measures to prevent and limit unintentional discharges to groundwater of non-radioactive substances

We have identified 1 Assessment Finding:

- **Assessment Finding 16**: A future operator shall appropriately characterise all aqueous waste streams in its water discharge activity permit application. This shall include identifying all significant contaminants (including biocides, detergents and metals), the concentrations and volumes being discharged to the environment.

Please read below for a summary of our detailed assessment and links to further supporting documents.

Discharges to surface waters

526. Hitachi-GE has provided the information on surface water discharges in Section 5 of its 'Other environmental regulations' submission.

527. Hitachi-GE states that the aqueous effluent streams generated from the UK ABWR are divided into the following categories:

- discharges from cooling water systems
- discharges from drainage networks in non-radioactive areas
- discharges from the drainage networks in the radioactive areas via the liquid waste management system
- effluent from the boiler blowdown and the purified water treatment facility (PWTF)
- rainwater

528. The original submission did not include sufficient information for some of these aqueous waste streams to enable us to determine whether the likely environmental impact from discharges to surface water would be acceptable from the UK ABWR. We raised a Regulatory Observation (RO-ABWR-0070) requiring Hitachi-GE to provide further information on the contaminants, volumes being discharged, treatments being employed, including assessment of environmental impact for various aqueous waste streams.

Cooling water discharges

529. Discharges from the cooling water systems will consist of once-through seawater cooling used in the CW, TSW and RSW systems. Potential contaminants will be scale washings, biocides and potentially iron. The scale washings consists of the solid matter that is removed during the cleaning of the condenser tubes. This material is mainly inert and will not have any environmental impact so does not need to be considered further.

530. Biocides will be used to prevent bio-fouling of the CW system. Hitachi-GE states that sodium hypochlorite is a suitable biocide to use in the UK ABWR. The dosing strategy will be implemented at the site-specific stage but will ensure that the chlorine level (measured as total residual oxidant) will not exceed the environmental quality standard (EQS) of 0.01 µg/l at the edge of the mixing zone. This is expected to result in a discharge concentration of 0.1 µg/l at the cooling water outfall.

531. Iron will be potentially used as a corrosion inhibitor in the heat exchangers in TSW and RSW systems. Usage levels will be 0.03 ppm during commissioning and 0.01 ppm during operations. It is only needed in a specific type of heat exchanger, although the final choice will only be decided at the site-specific stage.

532. Hitachi-GE states that there will be no treatment of the discharges from the cooling water systems. Monitoring will be carried out to ensure the discharge criteria are met.

Non-radioactive area discharges

533. The drainage networks from the non-radioactive areas are the service water storm drain (SWSD) and the non-radioactive storm drain (NSD) and will be free of radioactive contamination.

534. The SWSD discharge consists of seawater used in the heat exchangers as part of the reactor and turbine cooling water systems and should not be contaminated. The volume discharged is expected to be 24 m^3/day, with a maximum of 240 m^3/day during maintenance.

535. The NSD discharge will consist of purified water from the cooling water system used in the anciliary systems in the reactor and turbine buildings. The discharge will contain sodium nitrite, which is used as a corrosion inhibitor (up to 300 ppm). The volume discharged is expected to be 24 m^3/day, with a maximum of 240 m^3/day during maintenance.

536. Hitachi-GE states that there will be no treatment of the SWSW and NSD discharges. A radiation monitor will be installed in the NSD discharge line so the effluent can be transferred to the radioactive waste treatment facility, if necessary. We conclude that given the low levels of contamination, low volumes discharged and the significant volumes of dilution with cooling water, treatment is not necessary.

Radioactive area discharges

537. The drainage networks from the radioactive areas are the controlled area drain (CAD), high chemical impurities waste (HCW) drain, low chemical impurities waste (LCW) drain and laundry drain (LD). Together, these drainage systems make up the liquid waste management system (LWMS). The purpose of the LWMS is to treat the aqueous wastes so they can be reused in the UK ABWR and minimise discharges to the environment. Aqueous waste from the LD cannot be reused because it contains detergents. Aqueous waste from the CAD is not normally reused as it is expected to be free from radioactivity and volumes are minimal.

538. The CAD discharge is expected to be free from radioactive contamination as it receives drainage from non-radioactive equipment. Potential contaminants will be sodium nitrite (a corrosion inhibitor) at levels of 300 ppm. The expected volume of aqueous waste is 3 m^3/day.

539. This effluent will normally be discharged to sea without treatment, although it will be monitored before being discharged to ensure the discharge criteria are met. If it contains any chemical or radiological contamination the effluent will be transferred to the HCW system for treatment. We conclude that, given the very low levels of sodim nitrite, the minimal volume discharged and the significant volumes of dilution with cooling water, treatment is not necessary.

540. The HCW and LCW drainage systems receive contaminated liquid effluent from within the UK ABWR. The HCW is designed to treat higher levels of chemical contaminants than the LCW but lower volumes of effluent. Hitachi-GE states that the treatment will remove the chemical contaminants from the aqueous effluent. The main chemical contaminants in the HCW are various chemicals and reagents used in chemical analysis laboratory. These are typically mineral acids (hydrochloric, nitric and suphuric), sodium bicarbonate, potassium nitrate, silver nitrate and anion and cation eluents from chromatography. Annual usage is typically 200 ml for most chemicals up to approximately 8 litres. Discharges to sea can only occur from the HCW as there is no direct disposal route from the LCW drainage system.

541. We have raised Assessment Finding 16 to ensure that any future operator identifies all the contaminants within the aqueous effluents in its water discharge activity permit application. This information is essential to assess the full environmental impact from discharges to surface waters and enable a permit to be granted.

542. The HCW effluent is treated using an evaporator to concentrate and remove insoluble impurities followed by a demineraliser using ion-exchange resins to remove soluble impurities. The effluent is sampled following treatment and, if suitable, is reused in the reactor, otherwise it will be recycled through the treatment process. If there is not enough capacity within the reactor system, the effluent will be discharged to sea, but only if the discharge criteria are met. Hitachi-GE states that operational Japanese ABWRs are discharging to sea on average 2.5 batches of HCW each year. This is approximately 288 m^3/year, equivalent to 115 m^3 per batch.

543. We conclude that using an evaporator and demineraliser is suitable treatment for the HCW.

544. The LCW effluent is treated using filters to remove insoluble impurities followed by ion-exchange to remove soluble impurities. The effluent is sampled following treatment and, if suitable, is reused in the reactor, otherwise it will be recycled through the treatment process. Any effluent that cannot be reused is to be transferred to the HCW system for treatment. Any subsequent discharge to sea would be classed as part of the HCW discharge.

545. We conclude that using filtration and a demineraliser is suitable treatment for LCW.

546. The LD receives effluent from the laundry, showers and sinks in the controlled areas. This effluent cannot be reused within the UK ABWR because it contains detergents. Other contaminants in the discharge are suspended solids and organic matter. Hitachi-GE states that for the purposes of GDA an anionic surfactant based detergent will be used.

547. The LD effluent is treated using a combined filtration system to remove suspended solids and organic matter. The filtration system consists of a packed bed pre-filter, followed by an activated charcoal adsorption unit and finally a pre-coat carbon filter. Hitachi-GE states that the filtration system provides a decontamination factor (DF) of 300 for insoluble contaminants. The pre-filter removes coarse solid material. The activated charcoal adsorption unit contains bead activated carbon to adsorb organic impurities and smaller suspended solids that pass through the pre-filter. The pre-coat filters contain cartridges with a fabric sock pre-treated with granular activated carbon to trap small sized suspended solids.

548. We conclude that using filtration and activated carbon is suitable for treating LD aqueous waste.

Boiler blowdown and purified water treatment facility effluent

549. Boiler blowdown (removal of water from the boiler) will be generated when the auxiliary boilers are being used This will contain low levels of chemical contaminants from the treatment of the boiler feed water. These chemicals have been assumed to be phosphate for pH control, and hydrazine as an oxygen scavenger. The hydrazine will be broken down into nitrogen and water in the presence of oxygen. Phosphate is expected to be present in the boiler blowdown at 3 ppm. Hydrazine will be dosed at 0.2 ppm. Boiler blowdown will be 4.3 m^3/day.

550. The purified water treatment facility (PWTF) uses reverse osmosis and electro-deionisation to produce purified water from towns water. The aqueous waste produced contains the same constituents as towns water but at double the concentration. The expected volume of aqueous waste discharged is 450 m^3/day.

551. There is no treatment of these effluent streams. Both will be stored prior to batch discharge for mixing with the cooling water discharges. The significant dilution from the cooling water should ensure the levels of contaminants discharged to sea are negligible (see Impact Assessment below).

Rainwater

552. Treating rainwater will depend on where it falls within the UK ABWR site. The final strategy for managing rainwater will be site-specific and depend on the site topography, location and layout.

553. For GDA, rainwater within the inner fence is assumed to drain to the seal pit and be discharged with the cooling water. Rainwater from outside the inner fence may go direct to the sea.

554. Hitachi-GE states that drainage systems will have appropriate measures in place to manage spills of chemicals, such as oil interceptors.

Discharge criteria

555. Discharges to the sea of aqueous wastes will be from the cooling water systems (CW, TSW and RSW), boiler blowdown, PWTF, NSD, SWSD, CAD, HCW and LD. The cooling water discharges will be continuous, whereas the other discharges will be on an intermittent batch basis. All discharges will be via the seal pit.

556. Hitachi-GE has provided criteria for discharges to sea from the NSD, SWSD, CAD and LD and these are presented in Table 16.1 below. Hitachi-GE states that these are the criteria for the Japanese ABWR and demonstrate the level of control in place for an operational nuclear power plant. The finalised discharge criteria will be determined at the site-specific stage.

Table 16.1 - Discharge criteria provided by Hitachi-GE

Parameter	Level	
pH	5.8 – 8.6	
Chemical oxygen demand (COD)	<30mg/l	Daily maximum
	<20mg/l	Daily average
Suspended solids	<20mg/l	Daily maximum
	<15mg/l	Daily average
Concentration of normal hexane extract	<3mg/l	Daily maximum

557. We accept that the final discharge criteria for any discharges to surface water can only be determined at the site-specific stage.

558. The criteria above indicate that the levels of suspended solids and organic material, as measured by chemical oxygen demand (COD), in the discharged aqueous waste are low. The pH range is comparable to operational nuclear power plants in the UK. The concentration of normal hexane extract is a measure of the level of oil in the discharge. We would expect any discharge to have no visible oil.

559. Hitachi-GE has also included the acceptance criteria required for the condensate storage tank (CST), which is where the aqueous waste is stored prior to reuse in the UK ABWR. These acceptance criteria are presented in Table 16.2 below.

560. Hitachi-GE states that the HCW aqueous waste will only be discharged to the sea if there is not enough storage capacity within the CST. This indicates any HCW discharge to the sea meets these acceptance criteria.

Table 16.2 - Acceptance criteria for the condensate storage tank

Parameter	Acceptance threshold
Conductivity	<100 μS/m
pH	5.8 – 8.0
Chloride (Cl^-)	<20 ppb
Sulphate (SO_4^{2-})	<20 ppb
Total organic carbon (TOC)	<400 ppb

561. The levels of chloride, sulphate and TOC are extremely low, indicating minimal contamination. The pH range is similar to those for operational nuclear power plants within the UK. The conductivity of less than 100 μS/m indicates that there are low levels of ionic species in the HCW aqueous waste.

Impact assessment

562. Hitachi-GE has identified only a limited number of non-radioactive contaminants likely to be in the aqueous waste streams discharged to the sea. These are:

- sodium hypochlorite and degradation products used as a biocide in the cooling water systems
- iron from dosing of the cooling water systems at a maximum concentration of 3 ppm
- nitrite as a corrosion inhibitor in auxiliary equipment cooling systems at concentrations of 300 ppm
- detergents from use in the laundry
- very low volumes of various chemicals/reagents from use in the chemical analysis laboratory
- phosphates and hydrazine in the boiler blowdown

563. Environmental quality standards (EQS) for discharges into coastal waters are available for iron and chlorine as total residual oxidants (TRO). These are:

- iron – 1 mg/l
- chlorine (as TRO) – 0.01 mg/l

Hitachi-GE states that there is no EQS for hydrazine. A no observed effect concentration (NOEC) of 0.5 μg/l has been identified in an Environment Agency report on chemical discharges from nuclear power stations. The same report also states the most stringent United States Environmental Protection Agency (USEPA) criterion for phosphate as 10 μg/l.

564. Hitachi-GE has carried out an environmental impact assessment of discharges of iron. The impact assessment follows the Environment Agency H1 guidance methodology by comparing the

discharge concentration (DC) and process concentration (PC) of the iron against the relevant environmental quality standard (EQS). The DC is the concentration at the end of pipe before discharge in the environment. The PC is the concentration in the environment following initial dilution. The results are presented in Table 16.3 below.

Table 16.3 - Results of environmental impact assessment for discharges of iron

Chemical	Annual Release (kg)	DC (µg/l)	PC (µg/l)	EQS (µg/l)	DC/EQS (%)	PC/EQS (%)
Iron (0.03ppm)	4783	2.69	0.54	1000	0.27	0.05

565. The results show that there is minimal environmental impact from the discharge of iron to the sea. The PC and DC are worse case as they are based on discharge volumes of the TSW and RSW and do not take into consideration dilution from the CW discharge.

566. We conclude that the environmental impact of iron discharged to sea via the cooling water from the UK ABWR is likely to be acceptable for permitting.

567. Hitachi-GE has carried out a semi quantitative or qualitative impact assessment on biocides (sodium hypochlorite), phosphate, hydrazine and detergent.

568. When injected into water the chlorine in the sodium hypochlorite forms a number of residual oxidising species, including hypochlorous acid (HOCl), free chlorine and small volumes of by-products. These are referred to as total residual oxidants (TRO). The EQS for chlorine (as TRO) in seawater is 0.01 mg/l.

569. Hitachi-GE states that a dosing strategy for the sodium hypochlorite will be designed to ensure that the EQS is not exceeded at the edge of the mixing zone while still ensuring effective bio-fouling treatment. This is expected to result in a concentration of 0.1 mg/l at the cooling water outfall. This is similar to the TRO levels specified for cooling water from a newly permitted nuclear power station. Based on this, we conclude that the environmental impact from sodium hypochlorite dosing in the cooling water for the UK ABWR is likely to be acceptable for permitting.

570. Phosphate is present at a maximum concentration of 3 ppm in the boiler blowdown. Based on a minimum dilution of 9,100 m^3/hour from cooling water (lowest cooling water flow expected during outage), Hitachi-GE states the highest (worse case) predicted concentration of phosphate at the cooling water outfall is 1.5 µg/l. This is below the 10 µg/l USEPA criterion. Based on this, we conclude that the environmental impact from phosphate in the boiler blowdown for the UK ABWR is likely to be acceptable for permitting.

571. Hydrazine, under a worst-case scenario, could be present at 0.2 ppm if no degradation were to occur. Based on a minimum dilution of 9,100 m^3/hour from cooling water, Hitachi-GE states the highest predicted concentration of hydrazine is 0.1 µg/l at the cooling water outfall. This is below the no observed effect concentration (NOEC) level of 0.5 µg/l. Based on this, we conclude that the environmental impact from hydrazine in the boiler blowdown for the UK ABWR is likely to be acceptable for permitting.

572. Hitachi-GE assumes that an anionic surfactant based detergent will be used. The active ingredient (sodium;1,4-bis(2-ethylhexoxy)-1,4-dioxobutane-2-sulfonate) is present at a concentration of 75% and is reported to have no toxic effects on the environment or aquatic organisms. The annual usage of detergent is estimated to be 750 litres compared to an annual discharge of 2,245 m^3 of aqueous waste from the laundry. This will be significantly diluted by the cooling waste discharge (minimum of 9,100 m^3/hour).

573. We conclude that the environmental impact from the detergents as part of the laundry discharge from the UK ABWR is likely to be acceptable for permitting.

574. Sodium nitrite will be present at a maximum level of 300 ppm in the CAD and NSD aqueous waste streams. Given the minimal volumes discharged (3 m^3/day from the CAD and up to 240 m^3/day from the NSD) and the dilution from the cooling water (minimum of 9,100 m^3/hour), we conclude that the environmental impact from the sodium nitrite corrosion inhibitor discharged from the UK ABWR is likely to be acceptable for permitting.

575. We conclude that the environmental impact from HCW aqueous waste discharged from the UK ABWR is likely to be acceptable for permitting. This is based on:

- the extremely low volumes of chemicals discharged from the chemical analysis laboratory
- the minimal volume of HCW discharged (288 m^3/year based on Japanese operational experience)
- the very significant dilution from cooling water (typically 203,000 m^3/hour, minimum 9,100 m^3/hour)
- criteria for reusing HCW which infers minimal levels of organic contamination as indicated by a TOC (<400 ppb), minimal levels of ionic species (inorganic/metals) as indicated by conductivity (<100 µS/m) and minimal levels of sulphate (<20 ppb) and chloride (<20 ppb)

576. We conclude that the operator of a UK ABWR will need to ensure it identifies all substances in the aqueous effluents before submitting a water discharge activity permit application. This should include biocides, detergents and metals. The operator will also need to identify expected volumes of the different effluent streams (Assessment Finding 16).

577. The operator of a UK ABWR will also need to carry out an environmental impact assessment for all substances discharged to surface water as part of a water discharge activity permit application.

Impact of thermal discharges

578. Hitachi-GE states that in order to assess the environmental impact of the thermal plume from the cooling water discharge, accurate information is needed on how the receiving surface water behaves with the various substances discharged. This can only be achieved using computational modelling supported by localised monitoring data from the specific site.

579. Hitachi-GE has proposed that no thermal modelling is undertaken at the GDA stage because the thermal impact is site-specific.

580. We accept this proposal and the thermal impact of discharges to surface water has been agreed to be out of scope of GDA.

Discharges to groundwater

581. Hitachi-GE has provided the information on discharges to groundwater in Section 6 of its 'Other environmental regulations' submission.

582. Hitachi-GE’s UK ABWR states that there are no intentional discharges to groundwater.

583. The physical measures taken in the UK design to prevent and minimise unintentional discharges to groundwater are described in Section 6.3 of Hitachi-GE's 'Other environmental regulations' submission. These are:

- tank bunding
- tertiary containment
- hard surfacing areas in spill risk area (for example, loading bays, tanker bays)
- use of interceptors on drainage systems
- provision of spill kits
- a plumbing and drainage system to collect and segregate potential leaked water (for example, fire water run-off)

584. Hitachi-GE states that the following measures will also be implemented to minimise the potential for accidental spills and leaks and limit their impact to land or groundwater:

- staff training
- emergency response exercises
- vehicle routing
- delivery and off-loading procedures
- inspection and preventative maintenance programmes for pollution prevention equipment

585. We believe the pollution prevention measures identified above are suitable for preventing discharges to groundwater.

586. Diesel, which will be used in the combustion plant, will be subject to an environmental permit (see Chapter 17 below) and we will ensure that BAT is used to prevent any discharge to groundwater.

587. We will inspect facilities on specific sites during construction to ensure that appropriate pollution prevention measures are in place before operations commence.

Our overall conclusion on discharges to surface waters and groundwater

588. We conclude that:

- the UK ABWR design is likely to be acceptable for permitting for the discharge of non-radioactive substances to surface waters at any coastal site listed in NPS EN-6
- a permit for discharges to groundwater will not be required as there are no proposals for intentional discharges to groundwater (whether direct or indirect), and the design includes all necessary and reasonable measures to prevent and limit unintentional discharges to groundwater of non-radioactive substances

589. We have identified 1 Assessment Finding, as set out in the above paragraphs and at the beginning of this chapter.

You can find more details of our assessment of the impact of non-radioactive discharges in our report [AR11 - Assessment of other environmental regulations] (Environment Agency, 2017k).

17. Operation of installations

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

We conclude that:

- the conventional combustion plant is the only ancillary plant meeting a description in Schedule 1 of EPR16 (GB Parliament, 2016b)
- subject to the relevant Assessment Finding set out below, the conventional combustion plant is likely to be acceptable for permitting:
    - as an installation under EPR16
    - under the 'Greenhouse Gas Emissions Trading Scheme Regulations 2012' (GGETSR12) (GB Parliament, 2012)

We have identified 1 Assessment Finding:

- **Assessment Finding 17**: A future operator shall specify the minimum performance parameters of the combustion plant in its application for an installations permit.

Please read below for a summary of our detailed assessment and links to further supporting documents.

Identification of installations

Combustion plant

591. Hitachi-GE has specified the conventional combustion plant in Section 7.3 of its 'Other environmental regulations' submission. It will consist of:

- 2 auxiliary boilers, each with a gross rated thermal input of 24.1 *megawatt(thermal) (*MWth*)*
- 3 emergency diesel generators (EDG), each with a gross rated thermal input of 18 MWth
- 2 diesel driven back-up building generators (BBG), each with a gross rated thermal input of 6.14 MWth
- 1 diverse additional generator (DAG) with a gross rated thermal input of 18 MWth

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

593. As the total thermal input exceeds 20 MWth, the combustion plant is also a 'regulated activity' as defined in GGETSR12 and will require a permit under those regulations.

Other ancillary plant

594. In general, the only other ancillary plant found on a nuclear power station that might need a permit under EPR16 would be an on-site waste incinerator. Hitachi-GE confirms in its 'Other environmetal regulations' submission (Section 7.2) that the design does not include an on-site incinerator.

Combustion plant operations

595. Hitachi-GE states the EDGs, BBGs and DAG are classed as nuclear safety equipment and designed to supply back-up emergency electrical power in the highly unlikely event of loss of power on-site. The EDGs and BBGs will operate together if needed. The DAG is there to provide back-up if there is a common cause failure of the EDGs.

596. The EDGs and BBGs will operate during commissioning, routine testing and in the case of a loss of power. A single commissioning test is expected to be carried out for each EDG, BBG and the DAG and is expected to last for approximately 6 hours. Routine testing is expected to consist of a regular test of less than 3 hours every 18 months and a monthly surveillance test for less than 1 hour. The final commissioning and testing routine is a site-specific issue and will be determined once the EDGs, BBGs and DAG have been procured.

597. The auxiliary boilers provide steam to the site during start-up, normal operation and shutdown. Under normal operation both boilers are expected to operate at full load in winter and 1 boiler at 50% load during the summer, therefore, at least 1 boiler will be operational during most circumstances.

598. Hitachi-GE states that the final selection of the combustion plant (design of diesel generators and auxiliary boilers) will be carried out at the site-specific stage. This will be based on a review of suitable combustion plant and associated plant available and the selection will be based on the assessment of BAT.

599. The operator of a UK ABWR will need to ensure that it specifies the performance parameters before applying for a permit (Assessment Finding 17).

600. Hitachi-GE has compared the proposed technology in the combustion plant with the combustion sector guidance note and the 'How to comply with your environmental permit' guidance (Environment Agency, 2009). We have reviewed the information submitted and have the following comments:

- The site report is a site-specific issue and cannot be assessed at GDA.
- The EDGs, BBGs and DAG are needed for nuclear safety, are expected to only run for short periods of time and need to respond when required, so we accept that energy efficiency is not a main consideration.
- The main raw materials to be used will be diesel, water and lubrication oil. 22,776 tonnes of diesel are estimated to be used in a year based on 1 boiler operating continuously, and lube oil is estimated to be 5,000 litres/year. Other chemicals used in much lower quantities will be glycol, biocides and boiler water treatment chemicals.
- There will be no direct discharges to water from the combustion plant. Boiler blowdown and cooling water discharges will be directed to the wider cooling water drainage system within the UK ABWR. These volumes are minimal compared with the surface water discharges associated with the nuclear reactor plant.
- Point source emissions to air will consist mainly of oxides of nitrogen (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO) and particulate matter (PM).
    - Using ultra-low sulphur fuel (<0.001% by weight) will minimise emissions of sulphur dioxide. BAT can only be determined at site-specific stage, but, in principle, we accept this as BAT. As part of a permit application, a future operator would need to demonstrate that the combustion plant meets the appropriate emission limit values (ELVs) that apply.
    - Using low NO_x burners will minimise emissions of NO_x from the auxiliary boilers. BAT can only be determined at site-specific stage but, in principle, we accept this as BAT.

- Minimising emissions of NO_x from the diesel generators will rely on engine design and will not be finalised until the site-specific stage. Hitachi-GE has quoted a typical discharge concentration of 2,216 mg/m^3 for the EDGs. A future operator will need to carry out a BAT options appraisal as part of its permit application to demonstrate that the chosen engine design minimises emissions of NO_x. Improvements are taking place with engine design technology and we expect the operator to review the latest available equipment to identify BAT.
- Combustion efficiency techniques such as combustion chamber design, optimised fuel and air mixing, and tuning of engines will minimise emissions of carbon monoxide and particulate matter. BAT can only be determined at site-specific stage but, in principle, we accept this as BAT.

- As part of a permit application the operator will also have to demonstrate that the combustion plant would meet relevant emission limit values (ELVs) for SO_2, NO_x and PM that apply. We are unlikely to require continuous emission monitoring for emissions to air for the combustion plant given the size of the auxiliary boilers and the size and frequency of operation of the EDGs, BBGs and DAGs. The auxiliary boilers will likely need monitoring annually and the EDGs, BBGs and DAGs will likely need monitoring every 3 years.
- An assessment against noise, odour and vibration has not been carried out at GDA. This will be required as part of the permit application. Hitachi-GE states that all equipment for the combustion plant will be specified with suitable noise and vibration attenuation, where appropriate. Examples are appropriate silencing equipment for generator engine exhausts and pressure relief valves. Hitachi-GE considers that there is unlikely to be any specific measures for odour beyond those indicative measures specified in relevant guidance, and we agreed with this.

601. Hitachi-GE carried out an impact assessment of emissions to air from the combustion plant within the UK ABWR to demonstrate that the emissions could be shown as likely to be acceptable for permitting. It carried out the impact assessment in 2 stages:

- A screening assessment of the main process emissions (NO_x, SO_2, CO & PM) using the Environment Agency's H1 environmental risk assessment approach.
- A further screening assessment of the short-term NO_x emissions from the EDGs using the air dispersion model AERMOD (American Meteorological Society/Environmental Protection Agency Regulatory Model).

602. The initial screening assessment was used to assess the ground level concentrations of the combustion plant emissions against the applicable relevant short-term and long-term air quality standards. The assessment was carried out based on the operation of a single EDG, a single BBG and both auxiliary boilers. It was agreed that the DAG did not need to be included in the assessment as it will only be used as a replacement for an EDG and will, therefore, never operate at the same time. The long-term assessment was based on 20 hours of operation per year each for the EDG and BBG.

603. The initial screening assessment showed that the ground level concentrations of emissions of NO_x, SO_2 and PM from the EDGs and BBGs were significantly below the relevant long-term air quality standards (there is no standard applicable for CO). Long-term emissions from the auxiliary boilers were below air quality standards for SO_2 and PM but nearly 4 times above for NO_x. Short-term emissions were significantly greater than the air quality standard for NO_x from both the EDG and BBG (up to 175 times) and 9 times above from the auxiliary boilers. As a result of the high short-term NO_x emissions, we raised a Regulatory Observation (RO-ABWR-0060) requiring Hitachi-GE to demonstrate that the environmental impact of the emissions to air from the EDGs and BBGs would be acceptable.

604. The second screening assessment was carried out in response to RO-ABWR-0060 to provide a more realistic assessment of the impact of short-term emissions of NO_x from the diesel generators using a more sophisticated dispersion model. The H1 screening tool has limitations, particularly

when assessing short-term impacts, and can be over-pessimistic. The initial assessment using the H1 screening tool assumed an effective stack height of zero in the assessment due to the EDG and BBG having minimal stacks and being located in buildings next to significantly larger buildings. The second assessment was carried out using a variety of stack heights to demonstrate that by increasing the stack height the emissions could be acceptable for permitting. Increasing stack height increases the level of dispersion of any pollutants and, therefore, reduces ground level concentration.

605. The AERMOD screening assessment indicates that increasing the stack heights of the EDG and BBG to around 30 metres will reduce the impact of the short-term emissions of NO_x to acceptable levels. This type of stack height is not unrealistic on a nuclear site.

606. Hitachi-GE has recently made some small changes to the dimensions of the EDG and Rad Waste Buildings but has not resubmitted any of the air dispersion modelling. The changes will not alter the results from the H1 screening tool as the effective stack height used was zero. The changes are likely to alter the results from the AERMOD screening assessment, although this is not expected to be in a significant way, as there will only be a relatively small decrease in the effective height used in the modelling.

The final stack heights for the combustion plant are site-specific issues for the operator. It is acknowledged that the final plant layout and further detailed dispersion modelling may reduce the final stack heights needed. The purpose of these screening assessments was to show that the impact of emissions from the combustion plant on the UK ABWR could be realistically reduced to acceptable levels to potentially allow a permit to be issued. We do not believe that the changes to the building dimensions alter this position.

The operator will have to carry out site-specific air dispersion modelling as part of the permit application to demonstrate compliance with air quality standards and demonstrate that the environmental impact from the combustion plant installation is likely to be acceptable for permitting. As part of the air dispersion modelling, the operator will need to ensure that the exact building dimensions are used.

607. As part of the permit application, the operator will also need to consider whether there are any designated habitat sites, including Sites of Special Scientific Interest, Marine Conservation Zones, Special Protection Areas, Special Areas of Conservation or Ramsar Convention sites in the area and, if necessary, carry out appropriate habitats assessments.

Combustion plant - greenhouse gas emissions

608. We can only issue a greenhouse gas permit if there are acceptable proposals for monitoring the greenhouse gas emissions.

609. There are different approaches to monitoring greenhouse gas emissions that we have approved. These are based on measuring or calculating the emissions.

610. Hitachi-GE states that the proposed approach to monitoring greenhouse gas emissions will meet the requirements contained in 'General guidance for installations (MRR1)', which provides guidance on how to meet the requirements of the Monitoring and Reporting Regulations for Greenhouse Gas Emissions (EU, 2012). It will follow the standard method used for calculating emissions as outlined in MRR1. This involves measuring fuel inputs and process inputs and applying appropriate emission, process and oxidation factors to calculate the total emissions.

Our overall conclusion on operation of installations

611. We conclude that:

- the conventional combustion plant is the only ancillary plant meeting a description in Schedule 1 of EPR16

- subject to the relevant Assessment Finding set out in the above paragraphs and at the beginning of this chapter, the conventional combustion plant is likely to be acceptable for permitting:
    - as an installation under EPR16
    - as a regulated activity under GGETSR12

You can find more details of our assessment of the operation of installations in our report [AR11 - Assessment of other environmental regulations] (Environment Agency, 2017k).

18. Control of major accident hazards

This chapter covers our assessment of the applicability and requirements of the Control of Major Accident Hazards (COMAH) Regulations for the UK ABWR. Nuclear power stations may need to store 1 or more dangerous substances in certain quantities as defined in the regulations. Precautions to prevent a major accident to the environment, therefore, need to be considered.

We conclude that:

- the UK ABWR design involves storing hydrazine in quantities that exceed the upper tier COMAH thresholds during decommissioning activities
- the UK ABWR is likely to be acceptable in terms of the environmental requirements under the COMAH regulations

Please read below for a summary of our detailed assessment and links to further supporting documents.

Dangerous substances

613. In its submission, Hitachi-GE has estimated the quantities of chemicals that could potentially be stored on the site of a UK ABWR and compared these with the qualifying quantities of named substances to which the COMAH Regulations apply (GB Parliament, 2015). It has determined the quantities of chemicals needed both during operation and commissioning and decommissioning.

614. The following approach has been carried out to determine the quantities of chemicals to be stored at the GDA stage.

- Where the storage capacity of a container (tank or cylinder) for a chemical has been fixed, this has been used as the quantity to be stored in the COMAH assessment.
- Where the storage capacity of a container is not fixed but the safety case sets a quantity of a chemical to be stored, this quantity has been used in the COMAH assessment.
- Where the storage capacity of a container is not fixed, there is no specific safety case requirement but there is information on the usage of a specific chemical, as determined by the operation of the UK ABWR, then 7 days' supply for that chemical is taken to be stored on site for the COMAH assessment.
- Where there is no information available on the quantity of chemicals stored and there is no safety case requirement or usage figure, no COMAH assessment has been made. It is expected that these chemicals will be addressed at the site-specific stage.

615. The most significant chemicals are shown in Table 18.1 below:

Table 18.1 - Chemicals identified as being above, or close to, COMAH thresholds

Chemical	Quantity	Lower tier threshold (te)	Upper tier threshold (te)
Chemicals to be used on the UK ABWR during operation			
Diesel	2,419	2,500	25,000
Chemicals to be used on the UK ABWR during decommissioning			
Hydrazine	3.15	0.5	2

Note: The name categorisation threshold for hydrazine only applies if hydrazine is present at a concentration of greater than 5% by weight. The storage concentration for hydrazine will be determined at the site-specific stage, therefore, for GDA a concentration above 5% by weight has been assumed as a worst case.

616. Hitachi-GE states that the UK ABWR will be an upper tier COMAH establishment only when decommissioning is carried out. This is because the quantity of hydrazine stored (3.15 tonnes) exceeds the upper tier qualifying threshold of 2 tonnes and the concentration is assumed to be greater than 5% by weight.

617. Significantly lower levels of hydrazine (25 kg/y) are used during operations.

618. The UK ABWR will not be a COMAH establishment during operation as the amount of diesel (2,419 tonnes) is just below the lower tier qualifying threshold of 2,500 tonnes.

619. It should be noted, however, that the GDA is based on a generic site with only 1 reactor unit. It is likely that there will be 2 reactor units on each new build site, which would mean the site would be a lower tier COMAH establishment due to the storage of diesel during the operational phase.

620. As well as comparing individual named substances against the qualifying thresholds, operators are also required to carry out an assessment of all substances with the same generic hazard classification, in aggregation, to determine whether COMAH applies. The assessment utilises a sum of fractions approach.

621. Hitachi-GE also carried out an assessment of the quantities of chemicals to be stored against the qualifying thresholds of generic categories of dangerous substances. This assessment did not change the COMAH status identified above.

622. At the site-specific stage, the operator of a UK ABWR will have to identify all the chemicals that will be used along with their storage quantities, and carry out an assessment against the COMAH qualifying thresholds.

623. Operators of upper tier establishments need to notify the competent authority (ONR and us) and prepare a safety report. In the case where an establishment is already operational and falls under the COMAH Regulations due to an increase in the quantity of a chemical already used on site, this should be done 3 months before the increased quantity being brought on site. The operator will also need to demonstrate to the competent authority that all measures necessary have been taken to prevent major accidents and limit their consequences for people or the environment. The notification, safety report and demonstration are site-specific issues for the operator and have not been considered further during the GDA.

Measures to prevent a major accident to the environment

624. Hitachi-GE states that the UK ABWR will have prevention measures in place to avoid releasing hydrazine into the environment to prevent a major accident to the environment (MATTE).

625. Pollution prevention measures will include:

- storing hydrazine in suitable containers such as drums or intermediate bulk containers (IBC) within buildings, where possible

- all containers will be stored within suitable secondary containment systems such as bunds or drip trays, which are impermeable to water and attack from hydrazine
- all secondary containment systems will be of a suitable size

626. We accept that the relatively low levels of hydrazine stored during operations and the immediate dilution with cooling water means that the impact of any spillage to the sea would be limited. The likelihood of any MATTE from an accident involving hydrazine is minimal.

627. Hitachi-GE has also included information on the primary, secondary and tertiary containment measures in place to prevent a MATTE from the bulk storage of diesel. This was because a slight increase in the quantity (approximately 80 tonnes) of diesel stored on site would bring the UK ABWR into COMAH as a lower tier establishment.

628. Secondary containment measures include ensuring bund capacities are 110% of largest tank or 25% of the overall tank rated capacity, whichever is greater; walls, joints and floors must be impervious to hydrocarbons; walls must be capable of withstanding the hydrostatic pressures from a catastrophic tank failure; and concrete bunds must be constructed with reinforced floors and walls to the required standards.

Tertiary containment measures will include passive in situ engineered containment systems like bunds and lagoons with active measures such as remotely operated shut-off valves. The final design of the tertiary containment will be a site-specific issue depending upon the site layout.

Hitachi-GE has stated that the secondary and tertiary containment systems will be in accordance with the requirements of the COMAH Competent Authority ‘Policy for the bulk storage of hazardous liquids' (HSE, 2008). We will ensure any future storage of diesel above the COMAH threshold complies with the COMAH containment policy.

629. We conclude that the UK ABWR design includes appropriate measures to prevent a MATTE.

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

Our overall conclusion on COMAH requirements

631. The UK ABWR design involves storing hydrazine in quantities that exceed the upper tier COMAH levels during decommissioning.

632. The UK ABWR is likely to be acceptable in terms of the environmental requirements under COMAH.

You can find more details of our assessment of COMAH requirements in our report [AR11 - Assessment of other environmental regulations] (Environment Agency, 2017k).

19. Our overall conclusion

Our conclusion is that we can issue a statement of design acceptability (SoDA) for the UK ABWR. This is subject to the Assessment Findings identified in the previous chapters and listed in Appendix 2. In particular, this is valid only for a site meeting the identified generic site characteristics.

Expectations for site-specific permitting

We have identified a number of expectations for site-specific permit applications (Appendix 8). These are items that have not been addressed or fully addressed in GDA. This list is intended to help prospective operators make a complete application.

References

Reference	Author/publication/website
Beresford et al., 2007	D-ERICA: An integrated approach to the assessment and management of environmental risks from ionising radiation. Euratom 6th Framework Programmes, Contract Number FI6R-CT-2004-508847.
BERR, 2008	Meeting the Energy Challenge. A White Paper on Nuclear Power, BERR 2008.
Brown et al., 2016	A new version of the ERICA tool to facilitate impact assessments of radioactivity on wild plants and animals. Journal of Environmental Radioactivity, vol 153 pp141-148.
BSi, 2010	BS ISO 2889:2010: Sampling airborne radioactive materials from the stacks and ducts of nuclear facilities.
COMARE, 2011a	Committee on Medical Aspects of Radiation in the Environment (COMARE) FOURTEENTH REPORT. Further consideration of the coincidence of childhood leukaemia around nuclear power plants in Great Britain. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/304617/COMARE14threport.pdf
COMARE, 2011b	COMARE. 2011. Committee on Medical Aspects of Radiation in the Environment (COMARE) SEVENTEENTH REPORT. Further consideration of the incidence of cancers around the nuclear installations at Sellafield and Dounreay. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/554981/COMARE_17th_Report.pdf
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.
DECC, 2011a	National Policy Statement for Nuclear, Power Generation (EN-6). Volume I of II.

Reference	Author/publication/website
	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/37051/2009-nps-for-nuclear-volumeI.pdf
DECC, 2011b	National Policy Statement for Nuclear, Power Generation (EN-6). Volume II of II, Annexes. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/37052/1943-nps-nuclear-power-annex-volII.pdf
DECC, 2014a	Department for Energy and Climate Change. Implementing Geological Disposal, A Framework for the long-term management of higher activity. 2014. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332890/GDF_White_Paper_FINAL.pdf
DECC, 2014b	The justification of practices involving Ionising Radiation Regulations 2004: The Secretary of State’s decision as justifying authority on the regulatory justification of the UK Advanced Boiling Water Reactor (UK ABWR).
Defra, 2011	Environmental Permitting Guidance Radioactive Substances Regulation for the Environmental Permitting (England and Wales) Regulations 2010, September 2011, Version 2.0. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69503/pb13632-ep-guidance-rsr-110909.pdf
Environment Agency, 1999a	Environment Agency, 1999a. Technical Guidance Note M11: Monitoring of radioactive releases to atmosphere from nuclear facilities. London: The Stationery Office. (electronic copy available from the Environment Agency on request)
Environment Agency, 1999b	Environment Agency, 1999b. Technical Guidance Note M12: Monitoring of radioactive releases to water from nuclear facilities. London: The Stationery Office. (electronic copy available from the Environment Agency on request)
Environment Agency 2006	Initial radiological assessment methodology – part 2 methods and input data, Science Report: SC030162/SR2, May 2006.
Environment Agency, 2009	Environment Agency, 2009. How to comply with your environmental permit, Additional guidance for: Combustion activities (EPR 1.01). Bristol: Environment Agency.

Reference	Author/publication/website
	https://www.gov.uk/government/publications/combustion-activities-additional-guidance
Environment Agency, 2010	Environment Agency, 2010. Regulatory Guidance Series RSR 1: Radioactive Substances Regulation - Environmental Principles. Bristol: Environment Agency. https://www.gov.uk/government/publications/radioactive-substances-regulation-environmental-principles
Environment Agency, 2012	Environment Agency, 2012. Criteria for setting limits on the discharge of radioactive waste from nuclear sites. Bristol: Environment Agency. https://www.gov.uk/government/publications/discharge-of-radioactive-waste-from-nuclear-sites-setting-limits
Environment Agency, 2014a	Environment Agency, 2014. MCERTS: Minimum Requirements for the Self-Monitoring of Effluent Flow (version 4). Bristol: Environment Agency. https://www.gov.uk/government/publications/mcerts-minimum-requirements-for-the-self-monitoring-of-effluent-flow
Environment Agency 2014b	Generic design assessment of nuclear power stations - Report on initial assessment of Hitachi-GE Nuclear Energy Ltd's UK Advanced Boiling Water Reactor. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/348173/LIT_10001_GDA_Initial_Assessment_UK_ABWR_full_report.pdf
Environment Agency, 2015	MCERTS: Performance standard for organisations undertaking radioanalytical testing. Part 1 Radioanalytical testing of environmental and waste waters. Version 2, Environment Agency, 2015.
Environment Agency, 2016a	Discharges from boiling water reactors - A review of available discharge data (July 2016). https://www.gov.uk/government/publications/discharges-from-boiling-water-reactors-review-of-discharge-data
Environment Agency, 2016b	Process and information document for generic assessment of candidate nuclear power plant designs (version 3). Bristol: Environment Agency. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/562817/LIT_7998.pdf

Reference	Author/publication/website
Environment Agency, 2016c	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor Assessment report - Independent dose assessment. https://consult.environment-agency.gov.uk/engagement/gda-of-hitachi-ge-nuclear-energy-ltd/supporting_documents/Independent%20dose%20assessment%20report.pdf
Environment Agency, 2017a	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor Assessment report - AR01 Assessment of management arrangements. https://www.gov.uk/government/publications/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor-assessment-reports
Environment Agency, 2017b	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor Assessment report - AR02 Assessment of the strategic approach to waste management. https://www.gov.uk/government/publications/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor-assessment-reports
Environment Agency, 2017c	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor Assessment report - AR03 Assessment of best available techniques. https://www.gov.uk/government/publications/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor-assessment-reports
Environment Agency, 2017d	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor Assessment report - AR04 Assessment of gaseous radioactive waste disposal and limits. https://www.gov.uk/government/publications/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor-assessment-reports
Environment Agency, 2017e	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor Assessment report - AR05 Assessment of aqueous radioactive waste disposal and limits.

Reference	Author/publication/website
	https://www.gov.uk/government/publications/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor-assessment-reports
Environment Agency, 2017f	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor Assessment report - AR06 Assessment of solid radioactive waste and spent fuel. https://www.gov.uk/government/publications/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor-assessment-reports
Environment Agency, 2017g	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor Assessment report - AR07 Assessment of sampling and monitoring. https://www.gov.uk/government/publications/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor-assessment-reports
Environment Agency, 2017h	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor Assessment report - AR08 Assessment of generic site description. https://www.gov.uk/government/publications/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor-assessment-reports
Environment Agency, 2017i	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor Assessment report - AR09 Assessment of radiological impacts on members of the public. https://www.gov.uk/government/publications/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor-assessment-reports
Environment Agency, 2017j	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor Assessment report - AR10 Assessment of radiological impacts on non-human species. https://www.gov.uk/government/publications/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor-assessment-reports
Environment Agency, 2017k	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE's Advanced Boiling Water Reactor

Reference	Author/publication/website
	Assessment report - AR11 Assessment of other environmental regulations. https://www.gov.uk/government/publications/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor-assessment-reports
Environment Agency, 2017l	Technical Guidance Note M1: Sampling requirements for monitoring stack emissions to air from industrial installations, v8, Environment Agency, August 2017.
Environment Agency and Natural Resources Wales, 2016a	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE Nuclear Energy Limited's UK Advanced Boiling Water Reactor. Consultation document. https://consult.environment-agency.gov.uk/engagement/gda-of-hitachi-ge-nuclear-energy-ltd/supporting_documents/5.%20UK%20ABWR%20GDA%20Consultation%20document.pdf (English) https://consult.environment-agency.gov.uk/engagement/gda-of-hitachi-ge-nuclear-energy-ltd/supporting_documents/6.%20Dogfen%20ymgynghori.pdf (Welsh)
Environment Agency and Natural Resources Wales, 2016b	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE Nuclear Energy Limited's UK Advanced Boiling Water Reactor. Consultation document – Addendum. https://consult.environment-agency.gov.uk/engagement/gda-of-hitachi-ge-nuclear-energy-ltd/supporting_documents/3.%20UK%20ABWR%20GDA%20Consultation%20document%20Addendum.pdf (English) https://consult.environment-agency.gov.uk/engagement/gda-of-hitachi-ge-nuclear-energy-ltd/supporting_documents/4.%20Dogfen%20ymgynghori%20%20Atodiad.pdf (Welsh)
EU, 1996	1996 Basic Safety Standards Directive (BSSD) of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation. (96/29/Euratom). Note - Directive 2013/59/Euratom (EU, 2013) will repeal the 1996 Directive by 6 February 2018.
EU, 2004	Commission of the European Communities, 2004. Commission Recommendation on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation

Reference	Author/publication/website
	(2004/2/Euratom). Official Journal of the European Union, L 2, 36 - 46. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:002:0036:0046:EN:PDF
EU, 2010	European Commission 2010. Directive 2010/75/EU of the European Parliament and of the Council on Industrial Emissions.
EU, 2012	European Commission, 2012. Commission Regulation (EU) No 601/2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC. Official Journal of the European Union, L 181, 30 - 104. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32012R0601:EN:NOT
EU, 2013	Basic Safety Standards Directive (BSSD) of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, (2013/59/Euratom). This directive repeals Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. https://osha.europa.eu/en/legislation/directives/directive-2013-59-euratom-protection-against-ionising-radiation
EUR, 2001	European Utility Requirements for LWR Nuclear Power Plants Rev C Apr 2001 (Vol 2, Chapter 2, Section 5.2).
FSA et al., 2017	Radioactivity in Food and the Environment (RIFE), 2016. RIFE 22. https://www.gov.uk/government/publications/radioactivity-in-food-and-the-environment-2016-rife-22
GB Parliament, 1991	Great Britain. Parliament. House of Commons. The Water Resources Act 1991. London: The Stationery Office. http://www.legislation.gov.uk/ukpga/1991/57/contents
GB Parliament, 1995	Great Britain. Parliament. House of Commons. The Environment Act 1995. London: The Stationery Office. http://www.legislation.gov.uk/ukpga/1995/25/contents

Reference	Author/publication/website
GB Parliament, 1999	Great Britain. Parliament. House of Commons. Nuclear Reactors (Environment Impact Assessment for Decommissioning) Regulations 1999. http://www.legislation.gov.uk/uksi/1999/2892/contents/made
GB Parliament, 2000	Great Britain. Parliament. House of Commons. Freedom of Information Act 2000. London: The Stationery Office. http://www.legislation.gov.uk/ukpga/2000/36/contents
GB Parliament, 2004	Great Britain. Parliament. House of Commons. The decommissioning of the UK nuclear industry's facilities, 2004. https://www.gov.uk/government/publications/the-decommissioning-of-the-uk-nuclear-industrys-facilities
GB Parliament, 2006	Great Britain. Parliament. House of Commons. The Nuclear Reactors (Environmental Impact Assessment for Decommissioning) (Amendment) Regulations 2006. http://www.legislation.gov.uk/uksi/2006/657/introduction/made
GB Parliament, 2008a	Great Britain. Parliament. House of Commons. Department for Business Enterprise and Regulatory Reform, 2008. Meeting the Energy Challenge - A White Paper on Nuclear Power. London: The Stationery Office. http://webarchive.nationalarchives.gov.uk/20100512172052/http://www.decc.gov.uk/media/viewfile.ashx?filepath=what we do/uk energy supply/energy mix/nuclear/whitepaper08/file43006.pdf&filetype=4
GB Parliament, 2008b	Great Britain. Parliament. House of Commons. Energy Act 2008. London: The Stationery Office. http://www.legislation.gov.uk/ukpga/2008/32/contents
GB Parliament, 2009a	Great Britain. Parliament. House of Commons. Department of Energy and Climate Change, 2009. Statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment. London: Department of Energy and Climate Change. 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

Reference	Author/publication/website
GB Parliament, 2009b	Great Britain. Parliament. House of Commons. Statutory Instrument 2009 No. 3344. The Eels (England and Wales) Regulations 2009. London: The Stationery Office. http://www.legislation.gov.uk/uksi/2009/3344/contents/made
GB Parliament, 2010	Great Britain. Parliament. House of Commons. Statutory Instrument 2010 No. 675. The Environmental Permitting (England and Wales) Regulations 2010. London: The Stationery Office. http://www.legislation.gov.uk/uksi/2010/675/contents/made see also: http://www.legislation.gov.uk/uksi/2011/2043/contents/made
GB Parliament, 2011a	Great Britain. Parliament. House of Commons. Department of Energy and Climate Change, 2011. National Policy Statement for Nuclear Power Generation (EN-6). London: The Stationery Office. Available from: https://www.gov.uk/government/publications/national-policy-statements-for-energy-infrastructure
GB Parliament, 2011b	Great Britain. Parliament. House of Commons. Department of Energy and Climate Change, 2011. The Energy Act 2008 - Funded Decommissioning Programme Guidance for New Nuclear Power Stations. London: Department of Energy & Climate Change. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/70214/guidance-funded-decommissioning-programme-consult.pdf
GB Parliament, 2012	Great Britain. Parliament. House of Commons. Statutory Instrument 2012 No. 3038. The Greenhouse Gas Emissions Trading Scheme Regulations 2012. London: The Stationery Office. http://www.legislation.gov.uk/uksi/2012/3038/contents/made
GB Parliament, 2014	Great Britain. Parliament. House of Commons. Department of Energy and Climate Change, 2014. Implementing Geological Disposal, A Framework for the long-term management of higher activity radioactive waste. London: Department of Energy & Climate Change. https://www.gov.uk/government/publications/implementing-geological-disposal
GB Parliament, 2015	Great Britain. Parliament. House of Commons. Statutory Instrument 2015 No. 483. The Control of Major Accident Hazards Regulations 2015. London: The Stationery Office.

Reference	Author/publication/website
	http://www.legislation.gov.uk/uksi/2015/483/contents/made
GB Parliament, 2016a	Great Britain. Parliament. House of Commons. Cabinet Office, 2016. Consultation principles guidance. https://www.gov.uk/government/publications/consultation-principles-guidance
GB Parliament, 2016b	Great Britain. Parliament. House of Commons. Statutory Instrument 2016 No. 1154. The Environmental Permitting (England and Wales) Regulations 2016. http://www.legislation.gov.uk/uksi/2016/1154/contents/made
Hitachi-GE, 2016a	Process source term supporting document, GA91-9201-0003-00945 Revision 3.
Hitachi-GE, 2016b	Calculation of radioactive waste end user source term value, GA91-9201-0003-01083 Revision 3.
Hitachi-GE, 2016c	BAT Optioneering Report, GA91-9201-0003-00325, Revision 1.
Hitachi-GE, 2016d	Radioactive solid waste monitoring requirements, GA91-9201-0003-00629, Revision 1.
Hitachi-GE, 2017a	Demonstration of best available techniques, GA91-9901-0023-00001, Revision G, August 2017.
Hitachi-GE, 2017b	Approach to sampling and monitoring, GA91-9901-0029-00001, Revision H, August 2017.
Hitachi-GE, 2017c	UK ABWR Generic Design Assessment Radioactive Waste Management Arrangements, GA91-9901-0022-00001, Revision H, September 2017.
Hitachi-GE, 2017d	UK ABWR Generic Design Assessment Quantification of Discharges and Limits, GA91-9901-0025-00001, Revision G, August 2017.
Hitachi-GE, 2017e	UK ABWR Generic Design Assessment Prospective dose modelling, GA91-9901-0026-00001, Revision G, August 2017. Chapter 8.
Hitachi-GE, 2017f	Solid waste generation arising from operation and decommissioning GA91-9201-0003-00072, Revision 8, July 2017.

Reference	Author/publication/website
Hitachi-GE, 2017g	UK ABWR Generic PCSR Chapter 31: Decommissioning, GA91-9101-0101-31000, Revision C, August 17.
Hitachi-GE, 2017h	GA91-9901-0019-00001 Summary of the Generic Environmental Permit Applications, Rev H.
HPA, 2009a	Health Protection Agency, 2009. Application of the 2007 ICRP Recommendations to the UK - Advice from the Health Protection Agency, RCE-12. Chilton: Health Protection Agency. https://www.gov.uk/government/publications/international-commission-on-radiological-protection-2007-recommendations
HPA, 2009b	Health Protection Agency. 2009. Radiological Protection Objectives for the Land-based Disposal of Solid Radioactive Wastes. Docs of the HPA RCE-8. HPA, Chilton. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335110/RCE-8_for_web_v2.pdf
HSE, 2008	COMAH Competent Authority policy on containment of bulk hazardous liquids at COMAH establishments. http://naturalsols.co.uk/Control/COMAH%20-%20Authority%20Policy.pdf
IAEA, 2007	Strategy and methodology for radioactive waste characterisation, IAEA-TECDOC-1537, International Atomic Energy Agency, March 2007.
IAEA, 2009	Determination and use of scaling factors for waste characterisation in nuclear power plants, IAEA Nuclear Energy Series, NW-T-1.18, International Atomic Energy Agency, 2009.
ICRP, 2007	International Commission on Radiological Protection (2007). The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Annals of the ICRP, Vol. 37 Nos. 2-4.
ISO, 1994	ISO 10780:1994 The International Organisation for Standardisation, Stationary source emissions – Measurement of velocity and volume flow rate of gas streams in ducts.
Joint Regulators, 2013 (EA and ONR)	A guide to the Regulatory Process. http://www.onr.org.uk/new-reactors/ngn01.pdf

Reference	Author/publication/website
LLWR Ltd, 2008	Strategic BPEO Study in the Management of Combustible Low Level Radioactive Waste, October 2008.
LLWR Ltd, 2009	Strategic BPEO Study for Very Low Level Waste, August 2009.
National Assembly of Wales, 2012	National Assembly of Wales. Welsh Statutory Instruments. The Natural Resources Body for Wales (Establishment) Order 2012 (as amended) http://www.legislation.gov.uk/wsi/2012/1903/made
NDA, 2006	Strategic BPEO for Metallic Waste Management – Options Evaluation, April 2006.
NDA, 2014	Radioactive Waste Management Directorate, Guide to the Disposability Assessment Process, NDA document WPS/650/03, 2014.
NDA, 2015	Nuclear Decommissioning Authority Collection, Managing Waste, part of Radioactive and nuclear substances and waste. https://www.gov.uk/government/collections/managing-waste#higher-activity-wastes
NICoP, 2012	Clearance and radiological sentencing: Principles, processes and practices for use by the nuclear industry; A nuclear industry code of practice, Issue 2, December 2012, Nuclear Industry Safety Directors Forum.
Nuclear Industry Guide, 2017	The UK nuclear industry guide to: Clearance and radiological sentencing: principles, process and practices, Issue 2.01, May 2017, Nuclear Industry Safety Directors Forum.
ONR, 2014	Office for Nuclear Regulation, 2014. New nuclear reactors: generic design assessment - guidance to requesting parties (ONR-GDA-GD-001 Revision 1). Bootle: Office for Nuclear Regulation. http://www.onr.org.uk/new-reactors/ngn03.pdf
OSPAR, 1992	Oslo and Paris Commission, 1992. The Convention for the protection of the marine environment of the north-east Atlantic. http://www.ospar.org./site/assets/files/1290/ospar_convention_e_updated_text_in_2007_no_revs.pdf

Reference	Author/publication/website
RWM Ltd, 2015	GDA: Disposability assessment for wastes and spent fuel arising from operation of the UK ABWR, Part 1 & 2, Issue 1 [OFFICIAL-SENSITIVE].
RWM Ltd, 2016a	Generic Design Assessment: Summary of Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK ABWR. https://rwm.nda.gov.uk/publication/generic-design-assessment-summary-of-disposability-assessment-for-wastes-and-spent-fuel-arising-from-operation-of-the-uk-abwr/
RWM Ltd, 2016b	Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK ABWR Part 1: Main Report. https://rwm.nda.gov.uk/publication/generic-design-assessment-disposability-assessment-for-wastes-and-spent-fuel-arising-from-operation-of-the-uk-abwr-part-1-main-report/
Smith et al., 2009	Smith J.G. and Simmonds J.R. (2009) The methodology for assessing the radiological consequences of routine releases of radionuclides to the environment used in PC-CREAM 08. Health Protection Agency, report HPA-RPD-058.
UKRWI, 2017	UK Radioactive Waste Inventory, 2017. About radioactive waste - what are the main waste categories? http://ukinventory.nda.gov.uk/about-radioactive-waste/what-is-radioactivity/what-are-the-main-waste-categories/
Vives i Batlle et al., 2015	A method for estimating 41Ar, 85, 88Kr and 131m, 133Xe doses to non-human biota. Journal of Environmental Radioactivity, vol 144, pp 152-161.

20. List of abbreviations

Abbreviation	Details
ABB	Asea Brown Boveri
ABWR	Advanced Boiling Water Reactor
AC	Alternating current
AGR	Advanced gas-cooled reactor
ALARA	As low as reasonably achievable
ALARP	As low as reasonably practicable
ANOB	Areas of outstanding natural beauty
BAT	Best available techniques
BBG	Back-up building generator
BEIS	(Department for) Business, Energy and Industrial Strategy
BSI	British Standards Institution
BSS	Basic Safety Standard
BSSG	Berkeley Site Stakeholder Group
BWR	Boiling water reactor
CAD	Controlled area drain
C&I	Control and instrumentation
COD	Chemical oxygen demand
COMAH	Control of Major Accident Hazards
COMAH15	Control of Major Accident Hazards Regulations 2015
CST	Condensate storage tank
CUW	Reactor water clean-up system
CW	Circulating water system
DAG	Diverse additional generator
DC	Discharge concentration
DCO	Development Consent Order
DF	Decontamination factor
DRP	Design reference point
EA 95	Environment Act 1995
EAL	Environmental assessment level
EC	European Commission
EDG	Emergency diesel generator
EIADR	Environmental Impact Assessment for Decommissioning Regulations
ELV	Emission limit value

EPA 90	Environmental Protection Act 1990
EPR10	Environmental Permitting (England and Wales) Regulations 2010
EPR16	Environmental Permitting (England and Wales) Regulations 2016
EPR	European pressurised reactor
EPRI	Electrical Power Research Institute – an independent USA organisation
EQS	Environmental quality standard
ERICA	Environmental Risk from Ionising Contaminants: Assessment and Management
EU	European Union
EUR	European utility requirement
FAPs	Fission and activation products
FOIA	Freedom of Information Act
FP	Fission product
FSA	Food Standards Agency
GDA	Generic design assessment
GDF	Geological disposal facility
GEP	Generic environmental permit
GGETSR12	Greenhouse Gas Emissions Trading Scheme Regulations 2012
GW	Gigawatt
GWe	Gigawatt (electrical)
HAW	Higher activity waste
HCW	High chemical impurities waste
HEPA	High efficiency particulate air
HLW	High level waste
HPA-RPD	Health Protection Agency – Radiation Protection Division
HSE	Health and Safety Executive
HVAC	Heating, ventilating and air conditioning system
IAEA	International Atomic Energy Agency
IBC	Intermediate bulk container
ILW	Intermediate level waste
ILWS	Intermediate level waste store
INSA	Independent nuclear safety assessment
ISO	International standard organisation
iSoDA	Interim statement of design acceptability
IWS	Integrated waste strategy
JPO	Joint Programme Office
KBS-3	Kärnbränslesäkerhet-3 (A Swedish waste container type)
LCW	Low chemical impurity waste

LD	Laundry drain system
LLW	Low level waste
LLWR	Low level waste repository
LoC	Letter of compliance
LWMS	Liquid radioactive waste management system
LWR	Light water reactor
MATTE	Major accident to the environment
MCERTS	Monitoring certification
MDSL	Master document submission list
MVP	Mechanical vacuum pump
MW	Megawatt
MWe	Megawatt (electrical)
MWth	Megawatt (thermal)
NDA	Nuclear Decommissioning Authority
NFLA	Nuclear Free Local Authorities
NGO	Non-governmental organisation
NOEC	No observed effect concentration
NO_x	Nitrogen oxides
NPS EN-6	National policy statement for nuclear power generation
NRW	Natural Resources Wales
NSD	Non-radioactive storm drain
NWFRS	North Wales Fire and Rescue Service
OG	Off-gas system
ONR	Office for Nuclear Regulation
OPEX	Operational experience
P&ID	Process and information document
PAWB	People Against Wylfa B
PCER	Pre-construction environmental report
PC	Process concentration
PCI	Pellet cladding interaction
PCSR	Pre-construction safety report
PHE	Public Health England
PM	Particulate matter
PPC	Pollution prevention and control
PQP	Project quality plan
PRIS	Power reactor information system
PWR	Pressurised water reactor

PWTF	Purified water treatment facility
QA	Quality assurance
QMS	Quality management system
QNL	Quarterly notification level
REPs	(Radioactive substances) regulation environmental principles
RI	Regulatory Issue
RO	Regulatory Observation
RPV	Reactor pressure vessel
RQ	Regulatory Query
RSW	Reactor building service water system
RWA	Radioactive waste adviser
RWM	Radioactive Waste Management (Ltd)
SF	Spent fuel
SFP	Spent fuel pond
SFAIRP	So far as is reasonably practicable
SFIS	Spent fuel interim store
SILW	Solid intermediate level waste
SoDA	Statement of design acceptability
SQEP	Suitable qualified and experienced personnel
STAND	Severnside Together Against Nuclear Development
SWF	(Dry) solid (low level) waste facility
SWMS	Solid radioactive waste management system
SWSD	Service water storm drain
TGS	Turbine gland steam system
TOC	Total organic carbon
TRO	Total residual oxidants
TSW	Turbine building service water system
UK	United Kingdom
USEPA	United States Environmental Protection Agency
US NRC	United States Nuclear Regulatory Commission
VLLW	Very low level waste
WILW	Wet (solid) intermediate level waste
WLLW	Wet (solid) low level waste
WRA 91	Water Resources Act 1991

21. Glossary

Activation product: a material that has been subject to a neutron flux and has been made radioactive as a result.

Alpha activity: some radionuclides decay by emitting alpha particles that consist of 2 neutrons and 2 protons.

Assessment Finding: an unresolved issue of lesser significance than a GDA Issue and not considered critical to the decision to start nuclear island safety-related construction.

Becquerel: the standard international unit of radioactivity equal to 1 radioactive transformation per second.

- megabecquerel (MBq) – one million transformations per second
- gigabecquerel (GBq) – one thousand million transformations per second
- terabecquerel (TBq) – one million million transformations per second

Best available techniques (BAT): the latest stage of development (state of the art) of processes, of facilities or of methods of operation, which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste. In determining whether a set of processes, facilities and methods of operation constitute the best available techniques in general or individual cases, special consideration shall be given to:

- comparable processes, facilities or methods of operation that have recently been successfully tried out
- technological advances and changes in scientific knowledge and understanding
- the economic feasibility of such techniques
- time limits for installation in both new and existing plants
- the nature and volume of the discharges and emissions concerned

Beta activity: some radionuclides decay by emitting a beta particle. This has the same properties as an atomic electron. If the particle carries a positive charge it is known as a 'positron'.

Collective dose: the dose received by a defined population from a particular source of public exposure. This is obtained by adding the dose received by each individual in the population, and is expressed in units of man-sieverts (manSv). Within limits, collective dose can represent the total radiological consequences of the source on the group, over a certain period of time.

Decommissioning: the process of taking a facility, at the end of its life, permanently out of service and making its site available for other purposes.

Direct radiation: radiation that arises directly from processes or operations on premises using radioactive substances such as a nuclear power station, and not as a result of discharges of those substances to the environment.

Discharge: the release of gaseous or aqueous waste to the environment.

Disposal: includes:

- placing solid waste in an authorised land disposal facility without plans to retrieve it at a later time
- releases to the environment (emissions and discharges) of gaseous waste (gases, mists and dusts) and aqueous waste
- transfer of waste, together with responsibility for that waste, to another person

Dose: a general term used as a measure of the radiation received by people and usually measured in sieverts.

Dose constraint: a restriction on annual dose to an individual from a single source, applied at the design and planning stage of any activity. The dose constraint places an upper bound on the outcome of any optimisation study.

Dose limit: the UK legal dose limit for members of the public from all man-made sources of radiation other than from medical exposure is 1 mSv/y.

Final SoDA: the statement of design acceptability provided when all GDA Issues have been addressed to the Environment Agency's satisfaction.

Fission: the splitting of an atomic nucleus into approximately equal parts, either spontaneously or on impact with another particle, usually with an associated release of energy.

Fission products: radionuclides produced as a result of fission.

Gamma radiation: some radionuclides emit gamma radiation when they decay, usually accompanied by emission of an alpha or beta particle. A gamma ray is a discrete quantity of electromagnetic energy without mass or charge.

GDA Issue: an unresolved issue considered by regulators to be significant, but resolvable, and which requires resolution before nuclear island safety-related construction of the reactor could be considered.

GDA submission: the totality of documents presented to regulators in GDA, including the design reference, the GDA safety, security and environmental submissions and related supporting references.

GDA master document submission list: a 'live' document that lists all the individual documents making up the GDA safety, security and environmental submissions and all the supporting documents they reference, and identifies their current revision status.

Generic site envelope: the generic siting characteristics, specified by the requesting party, against which the regulators assess the acceptability of the design safety case. These characteristics, such as seismic hazard, extreme weather events and environmental receptors should, so far as possible, envelop or bound the characteristics of any potential UK site so that the reactors could potentially be built at a number of suitable UK locations.

High level waste (HLW): waste in which the temperature may rise, as a result of its radioactivity, to an extent that it has to be accounted for in designing storage or disposal facilities.

Interim SoDA: an interim statement of design acceptability, issued when there are GDA Issues for which the requesting party has provided a credible resolution plan.

Intermediate level waste (ILW): waste with radioactivity levels exceeding the upper boundaries for low level waste but which does not require heat generation to be accounted for in the design of disposal or storage facilities.

Low level waste (LLW): waste containing levels of radioactivity greater than those acceptable for disposal with normal refuse but not exceeding 4 GBq/tonne alpha-emitting radionuclides or 12 GBq/tonne beta-emitting radionuclides.

MCERTS: the Environment Agency's monitoring certification scheme. It provides the framework for businesses to meet our quality requirements for monitoring, through the use of MCERTS, certified or accredited monitoring techniques, personnel, and so on, where these are available. You can find current MCERTS standards here.

Man-sievert (manSv): a measure of collective dose.

Nuclear island safety-related construction: relates to construction of the main nuclear island, which includes the main reactor building and nuclear auxiliary buildings such as diesel generator buildings but does not include, for example, sea defences or the cooling water pump houses that are located away from the nuclear island.

Radioactive waste: waste that contains radioactivity above levels specified in the Environmental Permitting Regulations 2016.

Radioactivity: the property of some atomic nuclides to spontaneously disintegrate emitting radiation such as alpha particles, beta particles and gamma rays.

Radiological assessment: an assessment of the radiation dose to members of the public, including that from discharges, which will result from operation or decommissioning of a facility.

Radionuclide: a general term for an unstable atomic nuclide that emits ionising radiation.

Regulatory Issue (RI): a serious regulatory shortfall that is potentially significant enough to prevent provision of a SoDA, and which requires action and new work for it to be addressed.

Regulatory Observation (RO): a potential regulatory shortfall that requires further justification by the requesting party and further assessment by the regulators in the expectation that it can be resolved.

Regulatory Query (RQ): a request for clarification or further information resulting from the assessment process. It may result in an RO or RI being raised if the query cannot be satisfactorily resolved.

Representative person: an individual receiving a dose that is representative of the more highly exposed individuals in the population.

Sievert (Sv): a measure of radiation dose received.

- millisievert (mSv) – one thousandth of a sievert
- microsievert (µSv or microSv) – one millionth of a sievert
- nanosievert (nSv) – one thousandth of one millionth of a sievert.

Source term: the types, quantities, and physical and chemical forms of the radionuclides present in a nuclear facility that could potentially give rise to exposure to radiation, radioactive waste or discharges.

Symbols and units

MW	Megawatt
MWe	megawatt electrical
MWh	megawatt hour
GBq/y	gigabecquerels per year
GWeh	gigawatt per hour electrical
MBq/y	megabecquerels per year
µSv/y	microsievert per year
te	Tonne

Appendix 1 - SoDA

Cyfoeth Naturiol Cymru
Natural Resources Wales

Environment Agency

Generic assessment of candidate nuclear power plant designs

statement of design acceptability for the UK ABWR design

submitted by

Hitachi-GE Nuclear Energy Ltd.

The Environment Agency and Natural Resources Wales have undertaken a Generic Design Assessment of Hitachi-GE's UK ABWR, during the period December 2013 to December 2017, using the process set out in the document Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs[1+2].

The findings of our assessment are summarised in the document:

Decision Document for the Generic Design Assessment of Hitachi-GE's UK ABWR[3]

The Environment Agency and Natural Resources Wales are satisfied that Hitachi-GE has demonstrated the acceptability for environmental permitting of the UK ABWR on the generic site, as defined in Schedule 1.

This statement is provided as advice to Hitachi-GE, under section 37 of the Environment Act 1995 and the Natural Resources Body for Wales (Establishment) Order 2012 (as amended) (National Assembly of Wales, 2012). It does not guarantee that any site-specific applications for environmental permits for the UK ABWR will be successful.

The statement will remain valid for ten years from the date of issue. This is subject to no significant new information arising during that period which might call into question our original assessment of the UK ABWR.

Stephen Hardy	14 December 2017

Authorised on behalf of the Environment Agency

Tim Jones	14 December 2017

Authorised on behalf of Natural Resources Wales

References

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

   https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/296440/LIT_7998_3e266c.pdf

3. Decision Document for the Generic Design Assessment of Hitachi-GE's UK ABWR, Environment Agency, December 2017. LIT10714.

Schedule 1 – Scope of the GDA

This statement of design acceptability refers to the Hitachi-GE UK ABWR as described in the design reference documentation:

Document reference	Title	Version number
GA91-9901-0017-00001	Definition of Design Reference Point	B
GA91-1104-0002-00001 (XE-GD-0178)	Design reference for UK ABWR, September 2017.	8
GA91-0011-0003-00001 (XE-GD-0158)	Master Document Submission List (MSDL), November 2017.	14

Appendix 2 - Assessment Findings

Our Assessment Findings are summarised below, but should be read with the supporting information presented in our assessment reports to provide context (Environment Agency, 2017a - 2017k). We expect future operators to address the findings during the appropriate phase of any new build project.

Reference	Assessment Finding
Assessment Finding 1	A future operator shall provide details of how the proximity principle has been applied in its demonstration of best available techniques for solid and incinerable liquid wastes prior to active commissioning.
Assessment Finding 2	If appropriate, a future operator shall produce an assessment of best available techniques that covers all of its sites, noting economies of scale and other efficiencies in disposal of solid and incinerable liquid wastes across all of its sites before it starts active commissioning of the UK ABWR.
Assessment Finding 3	A future operator shall demonstrate that the UK ABWR will be operated in a manner that represents best available techniques, addressing in particular: • fuel selection • fuel and core management • avoidance of control rod failure in power suppression situations • consideration of all normal operational modes and stages of the reactor's life cycle • control of water chemistry • selection of demineraliser resins for liquid waste management systems
Assessment Finding 4	A future operator shall review the practicability of techniques for abatement of carbon-14 prior to operation.
Assessment Finding 5	A future operator shall assess the partitioning of carbon-14 between gaseous, aqueous and solid waste streams, during initial operations.
Assessment Finding 6	A future operator shall address the 15 forward actions as identified by Hitachi-GE in the 'Demonstration of best available techniques' submission - GA91-9901-0023-00001 Revision. G. August 2017. (Hitachi-GE, 2017a).
Assessment Finding 7	A future operator shall provide an evidence-based definition of the decontamination factors likely to be achieved for aqueous effluent treatment prior to operation and then compare these with the actual decontamination factors achieved during operation. Differences in expected and actual decontamination factors should be explained.
Assessment Finding 8	A future operator shall assess the chemical speciation of radioactivity in aqueous discharges. It shall consider the implications of this for the receiving environment so that discharges are shown to represent best available techniques.
Assessment Finding 9	A future operator shall, before procurement, provide detailed designs for solid radioactive waste management, storage and conditioning facilities that were covered at a conceptual level during generic

	design assessment, and demonstrate how these represent best available techniques.
Assessment Finding 10	A future operator shall demonstrate optimised management and disposal of solid radioactive wastes from the UK ABWR, addressing in particular: • conditioning of higher activity waste arisings to ensure disposability • selection of disposal routes for wastes at the low activity waste/high activity waste boundary • management of spent nuclear fuel and any associated secondary wastes to ensure disposability • selection of disposal routes for low activity waste
Assessment Finding 11	A future operator shall address the 12 forward actions identified in the 'Approach to sampling and monitoring' submission - GA91-9901-0029-00001 Revision H, August 2017, (Hitachi-GE, 2017b).
Assessment Finding 12	A future operator shall undertake tests to determine the particle concentration profile and whether multi-nozzle probes are required for the main stack sampling.
Assessment Finding 13	A future operator shall demonstrate, prior to reactor commissioning, that the final configuration of the sampling lines and the layout and positioning of the monitoring room are optimised.
Assessment Finding 14	A future operator shall demonstrate that, prior to procurement, the specific sampling and monitoring equipment for determining the discharges represents best available techniques and enables the EU recommended levels of detection to be met.
Assessment Finding 15	A future operator shall demonstrate that the systems and equipment used for monitoring and sentencing solid waste represent best available techniques.
Assessment Finding 16	A future operator shall appropriately characterise all aqueous waste streams in its water discharge activity permit application. This shall include identifying all significant contaminants (including biocides, detergents and metals), the concentrations and volumes being discharged to the environment.
Assessment Finding 17	A future operator shall specify the minimum performance parameters of the combustion plant in its application for an installations permit.

Appendix 3 - Hitachi-GE submission documents - 'Generic environmental permit'

Document reference	Title	Version number
GA91-9901-0019-00001	Summary of the generic environmental permit applications	Revision H
GA91-9901-0020-00001	Generic site description	Revision F
GA91-9901-0021-00001	Approach to optimisation	Revision F
GA91-9901-0022-00001	Radioactive waste management arrangements	Revision H
GA91-9901-0023-00001	Demonstration of BAT	Revision G
GA91-9901-0025-00001	Quantification of discharges and limits	Revision G
GA91-9901-0026-00001	Prospective dose modelling	Revision G
GA91-9901-0027-00001	Other environmental regulations	Revision G
GA91-9901-0028-00001	Alignment with the Radioactive Substances Regulation environmental principles (REPs)	Revision F
GA91-9901-0029-00001	Approach to sampling and monitoring	Revision H

Appendix 4 - Environment Agency Assessment Reports

Document Reference	Title
AR01	Assessment of management arrangements
AR02	Assessment of the strategic approach to waste management
AR03	Assessment of best available techniques
AR04	Assessment of gaseous radioactive waste disposal and limits
AR05	Assessment of aqueous radioactive waste disposal and limits
AR06	Assessment of solid radioactive waste and spent fuel
AR07	Assessment of sampling and monitoring
AR08	Assessment of generic site description
AR09	Assessment of radiological impacts on members of the public
AR10	Assessment of radiological impacts on non-human species
AR11	Assessment of other environmental regulations
IDA	Generic design assessment of the UK ABWR - Independent dose assessment

Appendix 5 - Consultation questions

Below is a full list of the questions that we asked for responses to, as part of our consultation on the UK ABWR design.

	Do you have any views or comments on our preliminary conclusions on:
1.	management systems?
2.	strategic considerations for radioactive waste management?
3.	the process for identifying best available techniques (BAT)?
4.	preventing and minimising the creation of radioactive waste?
5.	minimising the discharges and impact of gaseous radioactive waste, and our proposed limits and levels?
6.	minimising the discharges and impact of aqueous radioactive waste, and our proposed limits and levels?
7.	management and disposal of solid radioactive waste and spent fuel?
8.	monitoring of discharges and disposals of radioactive waste?
9.	the impact of radioactive discharges?
10.	radioactive substances permitting?
11.	water abstraction?
12.	discharges to surface waters and groundwater?
13.	operation of installations?
14.	the control of major accident hazards?
15.	the overall acceptability of the design?
16.	Additionally, do you have any overall views or comments to make on our assessment, not covered by previous questions?

Appendix 6 - List of respondents

Response reference	Respondent
ABWR-01	Individual
ABWR-02	South Gloucestershire Council
ABWR-03	Nuclear Free Local Authorities (NFLA)
ABWR-04	People Against Wylfa B (PAWB)
ABWR-05	Berkeley Site Stakeholder Group (BSSG)
ABWR-06	Individual
ABWR-07	Individual
ABWR-08	Severnside Together Against Nuclear Development (STAND) Against Oldbury
ABWR-09	Oldbury-on-Severn Parish Council
ABWR-10	Forest of Dean Green Party
ABWR-11	Action Against Nuclear
ABWR-12	Individual
ABWR-13	Individual
ABWR-14	Individual
ABWR-15	Anglesey County Council
ABWR-16	Lissajous Nucleonics Ltd.
ABWR-17	Individual
ABWR-18	Individual
ABWR-19	Individual
ABWR-20	11 named individuals, no organisation name given
ABWR-21	Individual
ABWR-22	Individual
ABWR-23	Individual
ABWR-24	Individual
ABWR-25	Individual
ABWR-26	Individual
ABWR-27	Individual
ABWR-28	Individual
ABWR-29	Individual
ABWR-30	North Wales Fire and Rescue Service (NWFRS)
ABWR-31	Individual

Response reference	Respondent
ABWR-32	Individual
ABWR-33	Food Standards Agency (FSA)
ABWR-34	Individual
ABWR-35	Public Health England (PHE)

Appendix 7 - List of all consultation responses and our replies

Appendix 7.1 Introduction

In response to our consultation, we received 35 (ABWR-01 to ABWR-35) responses from individuals and organisations, some of which were duplicates or blank. Full responses and the reference we have given them can be found in our Responses to GDA consultation for the UK ABWR, published July 2017 here. A list of respondents is also included in Appendix 6.

This appendix to our decision document addresses each response consistent with our regulatory responsibilities and our detailed assessment conclusions. We address each response in 1 or more of 3 sections to this appendix as follows:

- responses that fall wholly or partially within our regulatory remit and where there is some consideration that is within the scope of GDA (Section A7.2)
- responses that are generic in nature or that fall outside of the scope of our GDA remit (Section A7.3) - here we briefly explain why the response is out of scope
- responses that fall wholly or partially within the remit of another organisation and, therefore, outside our responsibility as an environmental regulator (Section A7.4) - here we identify who we have passed the response on to

Points raised within some responses are addressed within more than 1 section of this appendix, for example where some aspects of a response might be directly relevant to our remit and within the scope of GDA, whereas others fall outside of the scope of GDA or our regulatory remit. Where relevant, we provide references to where responses are also noted or assessed further, such as in our assessment reports. Table A7.1 below indicates in which section of this appendix aspects of each consultation response is addressed.

Table A7.1 Sections within this appendix where points raised in each consultation response are addressed

Response reference	Addressed in A7.2 (within regulatory remit and GDA scope)	Addressed in A7.3 (outside scope of our GDA remit)	Addressed in A7.4 (outside of our regulatory responsibilities)
ABWR-01		✓	✓
ABWR-02	✓	✓	
ABWR-03	✓	✓	✓
ABWR-04	✓	✓	✓
ABWR-05	✓	✓	✓
ABWR-06		✓	
ABWR-07	✓	✓	
ABWR-08		✓	✓
ABWR-09	✓	✓	✓
ABWR-10		✓	✓

Response reference	Addressed in A7.2 (within regulatory remit and GDA scope)	Addressed in A7.3 (outside scope of our GDA remit)	Addressed in A7.4 (outside of our regulatory responsibilities)
ABWR-11	✓	✓	✓
ABWR-12		✓	✓
ABWR-13	✓	✓	
ABWR-14	✓	✓	
ABWR-15	✓	✓	✓
ABWR-16	✓	✓	
ABWR-17		✓	
ABWR-18		✓	
ABWR-19	✓		
ABWR-20	✓	✓	✓
ABWR-21	✓	✓	✓
ABWR-22	✓		✓
ABWR-23		✓	
ABWR-24		✓	
ABWR-25	✓	✓	✓
ABWR-26		✓	
ABWR-27		✓	
ABWR-28	✓	✓	✓
ABWR-29	✓		✓
ABWR-30	✓		✓
ABWR-31		✓	
ABWR-32		✓	
ABWR-33	✓	✓	
ABWR-34		✓	
ABWR-35	✓	✓	

Appendix 7.2 Responses within our regulatory remit and within the scope of GDA

Table A7.2 below provides a summary of each point raised within the consultation responses received that falls wholly or partially within our regulatory remit, and where there is some consideration that is within the scope of GDA. We provide a response against each point raised and, where appropriate, reference to where the point is further addressed.

Where we quote consultation responses directly, we have not corrected spelling or grammar. Similarly, where responses refer back to our consultation questions by the wrong question number, we have not corrected that here.

Table A7.2 Responses to points raised by individuals and organisations that fall wholly or partially within our regulatory remit and within the scope of GDA

Referenced assessment reports (AR01 to AR11) are summarised in Chapters 5 to 18 of the decision document and are available here.

Summary of points raised		Our consideration of the points raised	Also noted in:
ABWR-02 South Gloucestershire Council (SGC)			
a	In response to consultation question 5, SGC commented on the importance of the scrutiny and maintenance of quality management systems throughout the ABWR lifecycle to give confidence to local communities in their effectiveness.	In GDA we assessed the Hitachi-GE management arrangements for the design of the UK-ABWR reactor. We noted that Hitachi-GE is certified to ISO-9001 and ISO-14001 and that it has systems in place to ensure the design includes high standards of environmental performance of its reactor. It will be for the future operator to work with Hitachi-GE to ensure that the reactor is operated to high environmental standards. This will be enforced through an environmental permit which the operator will need to apply for to the environmental regulator (the Environment Agency in England and Natural Resources Wales in Wales). Regulatory scrutiny of an operator's management systems will continue to be a part of our regulation to ensure continued permit compliance.	AR01 (Chapter 5)
b	In response to consultation question 6, SGC requested further evidence on how decommissioning will be facilitated to minimise waste and impacts on local people and the environment.	In our assessment report on strategic waste management (AR02), at the time of consultation, we identified a potential GDA Issue on decommissioning: *Potential GDA Issue 1 – Decommissioning of the UK ABWR. We require Hitachi-GE to: Provide sufficient evidence to demonstrate that the UK ABWR has been designed to*	AR02 (Chapter 6) and A7.3

Summary of points raised		Our consideration of the points raised	Also noted in:
		facilitate decommissioning and hence to minimise associated waste and impacts on people and the environment from decommissioning operations. We raised the potential GDA Issue because at the time of going to consultation we had not received the complete suite of documentation in the Hitachi-GE delivery schedule. We have continued to engage with Hitachi-GE in this area and have now reviewed additional submissions provided after the date of consultation and have assessed that they are appropriate for GDA. This potential GDA Issue is now closed. We have concluded that the UK ABWR design facilitates decommissioning, and uses BAT to minimise waste arising and impacts on people and the environment. We do, however, note that the scope of our GDA assessment is limited to a generic site. It will be the responsibility of a future operator to demonstrate the application of best available techniques to ensure a proposed facility will be decommissioned to minimise waste arisings and impacts to people and the environment, taking into account conditions at the proposed site.	
c	In response to consultation questions 7 and 8, SGC stated that they support the use of best available techniques (BAT) to prevent and minimise the creation of radioactive waste, minimise the discharges of radioactive waste to the environment and minimise the impact on people and the environment.	Consultation response noted.	N/A
ABWR-03 Nuclear Free Local Authorities (NFLA). **(This response is specifically noted as being to the AR05 Aqueous assessment report)**			
a	In sections 1 and 2 of their response, NFLA consider the location of spent fuel cooling ponds next to and above the reactors, outside of containment and request that the regulators undertake further review to consider:	We note that the design of the spent fuel pool (SFP) is such as to minimise leakage and escape of liquid coolant in normal operations. Hitachi-GE has excluded any exhaust ports and the design includes water leakage detectors and water-level alarm devices to monitor any possible leakage of the fuel pool water ('Demonstration of BAT Report', see 5.1.10.6. Evidence: Design	A7.4 and AR03 (Chapter 7)

<table>
<tr><th colspan="2">Summary of points raised</th><th>Our consideration of the points raised</th><th>Also noted in:</th></tr>
<tr><td></td><td>

the potential for breaches of spent fuel cooling pond containment
the processes and safeguards to reduce the risk of criticality and spent fuel cooling pond coolant loss in the event of breaches of containment
the long-term effectiveness of spent fuel pond emergency cooling water supply and application in severe events
the strategy for the collection, containment, treatment, safe management and disposal of escaped spent fuel pond coolant or emergency cooling water
clear strategies for the total prevention of spent fuel cooling pond coolant (or emergency cooling water) escaping to the environment
strategies for monitoring and analysis of all radionuclides in the spent fuel pond coolant or any emergency coolant water in the event of a breach, to assess the dose impact on humans and wildlife
Tokyo Electric Power Company's (TEPCO) statement that the weight of the emergency coolant water in the event of an accident could weaken the reactor building

</td><td>Policies and Principles for Leak Tightness in Fuel Pool) (Hitachi-GE, 2017a). No liquid discharge from the spent fuel pool is anticipated in normal operations and there are no direct discharge routes to the environment from the pool. As there are no liquid discharges from the SFP we will not have assessed radioactivity of the SFP water. We would not ask for monitoring of radionuclides to be undertaken where there are no discharges. We have considered the activity on the SFP clean-up resins and their final activity and volume for waste disposal. We also considered the BAT aspects of SFP management that could impact on resin activity, SF integrity or disposability, such as pH and temperatures. Routine monitoring of the SFP will be undertaken for reasons such as worker dose, but as this is outside our legal responsibilities we have not assessed it. We have, however, passed this consultation response on to ONR for its consideration.

Monitoring of any liquid waste arisings in accident scenarios is not within the scope of our assessment in GDA, which considers only ‘normal’ operations as defined in the Environment Agency ‘Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs’ (Environment Agency, 2016b).

Gaseous discharges via the spent fuel pool are expected in normal operations via evaporation of coolant and entrainment in the heating, ventilation and air conditioning system. A source term of volatile radionuclides from the spent fuel pool has been considered in our assessment.</td><td></td></tr>
<tr><td>c</td><td>In section 4, NFLA notes that the assessment report contains no discussion on washout from gaseous discharges and their fate and behaviour, with reference to accident scenarios (Fukushima & Chernobyl). NFLA requests that the regulators:</td><td>For assessment of discharges to atmosphere under normal operations, wet deposition and dry deposition onto the ground and onto plants are considered as standard processes to represent washout and fallout. Uptake into plants and the food chain are considered.</td><td>AR09, 10

(Chapter 13)

and

A7.4</td></tr>
</table>

Summary of points raised		Our consideration of the points raised	Also noted in:
	• examine the issue of washout and fallout as additional inputs to the marine coastal environment • review available empirical scientific data on the washout and fallout of atmospheric radioactive discharges, including the fate of all forms of atmospheric waste under a range of conditions for all nuclides • where there is an absence of such data, model or calculate appropriate factors, referencing all empirical input data • The review should include un-planned discharges as derived from historical data from current UK sites and Japanese BWRs ABWRs	Accident situations will be assessed by ONR. For normal operations, wet deposition (washout) is linked to rainfall frequency. There is a frequency of rain considered in the assessment of discharges under normal operations, linked to location in the UK, the usual atmospheric categories and frequency of their occurrence. For the GDA assessment by Hitachi-GE, the frequency of rain is based on that at the Wylfa site. The main atmospheric discharges in terms of quantity are tritium and carbon-14 during normal operations. The main uptake mechanisms for these radionuclides are linked to photosynthesis and water uptake. However, both tritium and carbon-14 can also be washed out by rain. Other radionuclides are taken up through direct deposition onto plant leaves and uptake from soil. Deposition is modelled via both dry and wet deposition process. An assessment of wet deposition into the marine environment is not required from the requesting party under GDA guidance, but we will consider this further at the site-specific stage.	
d	In section 5 of its response, NFLA raised concern that the relevant guidance on ‘significant nuclides’ is outdated, with reference to Pu-241 (and its progeny Am-241) and that Am-241 generated from Pu-241 is not addressed. NFLA requested that the regulators review Am-241 production from Pu-241, in doing so considering: • the total and annual Pu-241 activity discharged and Am-241 generated • the time line for Am-241 generation (with reference to pulsed Pu-241 discharges)	We note that the guidance referred to is still valid, both Pu-241 and Am-241 are considered where applicable. The nuclide selection methodology used by Hitachi-GE takes approximately 600 nuclides derived from the ORIGEN code and applies a down-selection method based on dose impact, activity concentration and regulatory requirements for the particular end user. The down selection process for the discharge end-user source term (EUST) reduced the list of nuclides to 34. Pu-241 is not in this list of nuclides relevant to gaseous or liquid discharges. This means that whilst the ORIGEN calculations indicated that Pu-241 could theoretically be present, concentrations and impact would be so small that it can be considered to be negligible. The models Hitachi-GE used to assess impact allow for Am-241 in-growth from Pu-	AR05 (Chapter 10)

Summary of points raised		Our consideration of the points raised	Also noted in:
		241. Therefore, had Pu-241 and the ingrown Am-241 been a significant dose contributor or at significant concentrations it would have been included in the reduced list of significant radionuclides.	
e	In sections 6, 7 and 8 of its response, NFLA refer to discharges of tritium and note that neither the relevant guidance on 'significant nuclides' (EU 2004) nor assessment reports refer to the possibility of discharged tritium quickly becoming organically bound tritium (OBT). NFLA referenced a 2001 study (McCubbin et al. 2001) that suggests that pulsed discharges could result in peaks in biota concentrations due to rapid tritium uptake and raised a concern over treating tritium discharges exclusively as tritiated water (with reference to a paper by Turner et al. 2009).	In Section 3.4.2 of the aqueous assessment report (AR05) we noted that the GEP submission contains no information on the expected chemical speciation of activity within the aqueous waste discharged. Speciation is the physio-chemical form of the activity in the aqueous waste which may affect the behaviour of the radioactivity in the receiving environment. We recognised that the data is not available at this stage to consider this aspect as the organic content of the receiving environment will be a factor in how a radionuclide behaves in the environment. However, we did include an Assessment Finding (AF8) to ensure that a future operator would consider the physio-chemical properties of the radionuclides discharged. *Assessment Finding 8: A future operator shall assess the chemical speciation of radioactivity in aqueous discharges. It shall consider the implications of this for the receiving environment so that discharges are shown to represent the best available techniques.*	AR05 (Chapter 10) and A7.3
f	In section 9 of its response, NFLA notes that there is a strong body of evidence to suggest that there are high concentrations of organic material in the Wylfa Newydd marine environment and, therefore, request that the regulators examine the issue of tritium discharges with specific reference to: • subsequent formation of organically bound tritium after discharge • the annual cycle of organic content of receiving waters • bio-accumulation rates (for peak short-term uptake)	See response to Point e above.	A7.3

Summary of points raised		Our consideration of the points raised	Also noted in:
	• expected doses to people and wildlife from organically bound tritium (including sea to land transfer) • contributions from gaseous discharges via washout and fallout		
g	In section 10 of its response, NFLA notes that the discharge data are not based on empirical data and is reliant of modelled data. NFLA raised concerned that as there is no empirical data, discharges and impact cannot be assessed. NFLA requested that the regulators: • (i) review the most recent data on liquid discharges from precursor BWRs and ABWRs for each nuclide expected to be found in the liquid discharges • (ii) process the empirical data for the annual and lifetime aggregated discharges expected from the UK ABWR • (iii) provide all available data for Pu, Am and Cm isotopes and tritium for BWRs, ABWRs and proposed UK ABWRs • (iv) where data cannot be acquired, it was explained how the following were calculated: discharges, environmental concentrations and the impact for each and every nuclide and how dose can be verified prior to discharges occurring.	g(i). The source term for discharges is based on a mix of empirical data and modelling. At existing stations, in accordance with local regulations, some radionuclide discharges have not been monitored and reported so there are no recorded discharge data; for these radionuclides modelling was employed to conservatively estimate discharges. g(ii). Any available appropriate empirical data has already been included. Further processing of this data does not need to be repeated. g(iii). Discharges of tritium from precursor or existing BWRs and ABWRs is available in our report 'Discharges from boiling water reactors: review of discharge data' published on 20 July 2016 (Environment Agency, 2016a). Discharges of plutonium, americium and curium from precursor BWRs and ABWRs are not reported separately as this data is not available. Details of discharges from proposed UK ABWRs of plutonium, americium, curium and tritium can be found in Chapter 7 of the GDA application published by Hitachi-GE 'Quantification of Discharges and Limits' (Hitachi-GE, 2017d). g(iv). Hitachi-GE has published information on derivation of the source term for discharges in Chapter 7 of the GDA application 'Quantification of Discharges and Limits'. This chapter considers all the radionuclides generated in the reactor, from activation or from fission of the nuclear fuel and their routes out into the environment as discharges or in solid waste. The radionuclides that are included have been assessed for significance. The radionuclides that are assessed as part of the discharges are included in Chapter 7. The environmental levels from discharges are predicted using dispersion models.	AR09, 10 (Chapter 13)

Summary of points raised		Our consideration of the points raised	Also noted in:
		Dispersion models used were created with input from environmental monitoring and measurements (empirical data). Data used in the models are also empirically based. The data used in the modelling has been verified against measurements. The data and modelling used are reviewed periodically and up to date data published by the International Atomic Energy Agency (IAEA). UK assessments are based on the IAEA data. The modelling takes into account radioelement environmental behaviour and radioactive decay and progeny ingrowth. Because of the empirical (measurement) basis of the data used, the model outcomes are partially verified. The environmental levels will be checked by our routine programme of environmental monitoring and reported on, such as in the annual Radioactivity in the Food and the Environment (RIFE) report (FSA et al., 2017).	
ABWR-04 People Against Wylfa B (PAWB)			
a	PAWB stated its dissatisfaction with the consultation process, stating that the Magnox based meeting venue was inappropriate, inaccessible by public transport and non-neutral.	For the consultation of our findings of the generic design assessment (GDA) of the Hitachi-GE design, Natural Resources Wales held 4 public events. The first was a joint stakeholder event with the Environment Agency in Birmingham and 3 events on Anglesey. The Environment Agency held similar local events in the Oldbury area, South Gloucestershire, England. We decided to focus on holding our events on Anglesey on the basis that a developer has proposed to use the design (if accepted by regulators) at the site at Wylfa. For the initial consultation on our findings of the generic design, Natural Resources Wales decided to hold 3 events, which it felt was proportionate for this stage in the process. The first was at Cemaes, close to 1 of Horizon Nuclear Power's proposed locations, and the second at Llangefni. In addition and at the request of the Horizon Wylfa Newydd Project Liaison Group (PLG), we also held a separate evening stakeholder meeting located at the proposed site adjacent to the current Magnox site. This meeting venue is the regular meeting place	Chapter 2 - Consultation

	Summary of points raised	Our consideration of the points raised	Also noted in:
		of the PLG to which we had been invited to speak. The location of the evening event was chosen because it is the usual location for Horizon Nuclear Power's Wylfa Newydd Project Liaison Group (PLG), a forum made up of stakeholder and community representatives that convenes regularly to discuss the proposed project and associated issues. In order to extend the invitation to the event in addition to the attendees of the forum, we invited representatives from an exhaustive list of stakeholders, including community groups.	
b	PAWB were concerned that (at a drop-in session at Llangefni) neither the Environment Agency, Natural Resources Wales, ONR nor Hitachi-GE could answer, when asked, how much high level waste (in TBq) would be stored on site with 2 ABWR reactors operating for 60 years and how that compared with Sellafield.	On the day of the drop-in session at Llangefni the regulators did not have the information to hand when asked this question. We asked that the question was submitted in writing to enable us to respond as accurately as possible once we had access to the relevant data. We have subsequently provided a written response (see our response to ABWR-19).	A7.4 and Chapter 2 - Consultation
c	PAWB were concerned that (at a drop-in session at Llangefni) neither the Environment Agency, Natural Resources Wales, ONR nor Hitachi-GE showed awareness of the performance of similar reactors in Japan, the reason for the low load factor or that an ABWR proposed for Texas was abandoned in March 2011 due to lack of investment interest.	As regulators we require the requesting party to identify and consider relevant learning from international developments. We are satisfied that Hitachi-GE has done this adequately within its submissions. See also our response to ABWR-09a. We are only able to assess a reactor's environmental performance within the scope of relevant legislation. We cannot judge a design on the basis of commercial success as a result of investor or operator decisions.	A7.3
d	As part of their consultation response, PAWB replied with a leaflet, part of which raised concern around the consultation process, stating that: • Natural Resources Wales is only consulting on normal operations and not consulting on abnormal behaviours or accidents	The consultation was for the environmental regulators to publish their draft decision about the environmental issues and controls connected with a generic reactor design for England and Wales. The responsibility of the assessment of abnormal behaviours and accidents of the generic reactor design falls under the remit of ONR, where a copy of this response has been sent (see Section A7.4 for further details). Please contact ONR for further information.	Chapter 2 and A7.3 A7.4

	Summary of points raised	Our consideration of the points raised	Also noted in:
	• Natural Resources Wales is not asking if the Welsh people accept the reactor • Natural Resources Wales is conveniently noting that the problem of nuclear waste is the responsibility of the Welsh and UK governments	The policy for nuclear energy and nuclear waste is the responsibility of government. It is our role, together with ONR, to regulate nuclear site operations from design, construction, operation and decommissioning. In addition to GDA which assesses a generic reactor design on a non-site-specific basis, we also conduct our regulatory roles via a system of site-specific environmental permits which are subject to a determination (assessment) phase of a site-specific application. Only if we find the application acceptable, will we issue permits to a site operator. We then regulate the operator's compliance with these permits which include strict operating conditions and limits that the operator must comply with by law.	
e	PAWB responded that the proposed 2 large reactors at Wylfa Newydd will be the largest reactors in Wales and with the waste stores will create a triple risk of a nuclear accident.	Responsibility for assessing the generic design for accident risk lies with ONR and we have passed this response to them. The dose assessment made under GDA is for a single reactor at a generic site. The generic site used is defined by Hitachi-GE and we have assessed this and concluded that the generic site description is appropriate for the purpose of the GDA. If an application for a permit for a new nuclear power station is received, a site-specific assessment will be made as required by the permit application process. A power station is likely to have 2 UK ABWRs and this would be assessed at that stage. Direct radiation doses from waste stores by any potential operator will also be provided as part of the site-specific permit application. The GDA assessments made so far show that doses will be well below the site dose constraint of 0.3 mSv/y.	A7.3 A7.4 Also see AR08 (Chapter 13)
ABWR-05 Berkeley Site Stakeholder Group			
a	In response to consultation question 3 (related to best available techniques), the respondent presumed that any proposal would only be acceptable if it gave an acceptable outcome.	Yes, we would only issue permits for an acceptable facility with evidence that a design is optimised and that all practicable measures have been taken to minimise waste arisings and any resulting environmental impacts. An acceptable outcome is one that not only meets relevant dose constraints but also demonstrates optimisation via the application of BAT.	AR03 (Chapter 7)

	Summary of points raised	Our consideration of the points raised	Also noted in:
b	In response to consultation question 4 (related to waste prevention and minimisation), the respondent stated that the key issue is the size of the source term and that it is disappointing that GDA Issue 2 has not been resolved prior to consultation.	Regulatory Issue RI-ABWR-0001, concerned with source terms for the UK ABWR, was closed on 17 October 2016. The closure of RI-ABWR-0001 was noted in our addendum (Environment Agency and Natural Resources Wales, 2016b), which was published alongside our consultation document [note that the date in the addendum is 17 Oct 2016 but the closure letter is dated 19 Oct 2017]. The closure report is available to view on the regulators' joint website. Regulatory Observation RO-ABWR-0006, concerned with source terms for UK ABWR, was closed on 3 April 2017. The closure letter is available to view on the regulators' joint website.	AR04 (Chapter 9)
c	In response to consultation question 4 (related to waste prevention and minimisation), the respondent felt that most reactor vendors overstate the reliability of their fuel and that this could be the case here. They raised concern that there is no comparative analysis of ABWR fuel reliability and that if the reliability of the fuel is lower than claimed then the turbine would become more contaminated than claimed. The respondent raised tritium as an issue, stating that it is difficult to predict in water reactors and that they feel insufficient attention has been paid to the probability of tritium contamination of the turbines and condenser, which is relevant to decommissioning.	We note that Hitachi-GE has proposed the use of the GE14 fuel design in the UK ABWR. The GE14 fuel design is deployed in other BWR reactor types and has been the subject of progressive development and optimisation (Solid Waste and Spent Fuel assessment report, AR06). Hitachi-GE provided evidence of features of the GE14 design which should reduce the likelihood of fuel failures, see Demonstration of BAT (Hitachi-GE, 2017a). We do, however, note that fuel technology will progressively improve and have, therefore, identified an Assessment Finding in our BAT assessment report (AR03) that will require a future operator to demonstrate that the UK ABWR will be operated in a manner that represents best available techniques, taking into consideration developments in fuel design and operating conditions to minimise the generation of waste and fuel failures. Hitachi-GE has demonstrated that tritium will not be a major contributor to the decommissioning source term, partly as a result of decay time and also due to decontamination. Hitachi-GE has proposed that prior to decommissioning, the active systems, including the turbines, will be decontaminated. This will remove surface contamination on internal components and leave activation products within the material structure, such as Co-60, as the main	AR06 (Chapter 11) and AR03 (Chapter 8) and A7.4

Summary of points raised		Our consideration of the points raised	Also noted in:
		source of activity in the decommissioning source term.	
d	In response to consultation question 5 (gaseous discharges), the respondent highlighted an error in the first table of Chapter 9 where units are given in GBq but should be in Bq.	Error noted and has been corrected.	AR04 (Chapter 9)
e	In response to consultation question 5, (gaseous discharges), the respondent noted that C-14 discharges are relatively high and supported Assessment Finding 6 to investigate C-14 removal techniques.	Consultation response noted.	AR04 (Chapter 9)
f	In response to consultation question 5, the respondent noted that H-3 and C-14 discharges are higher than for other BWRs, which supports the need for further work on minimising the generation and/or abatement of these radionuclides from this design.	Hitachi-GE provided a response to RQ-ABWR-1117 explaining the conservatisms of the approach used to derive carbon-14 and tritium (H-3) discharge estimates. By making conservative assumptions in the source term calculations, the expected discharges will appear to be higher than they are likely to be in reality. Using these higher values we note that impacts are still well below all dose limits and constraints.	AR04 (Chapter 9)
g	In response to question 7, (solid waste), the respondent raised concern that paragraphs 335 – 339 are not reassuring and suggest Hitachi-GE does not have a strong grasp on solid radioactive waste issues and that the regulatory response seems weak. The respondent stated that they expected a specific Assessment Finding on this and that they do not agree that the assessment should be left to the site-specific stage.	We note that it has been difficult to obtain data on the solid waste arisings from comparable power stations. We have, however, compared the estimated arisings from a UK ABWR to those from the AP1000 and EPR designs (as assessed in previous GDAs) and found these to be comparable. In addition, RWM has concluded that the waste streams containing the main source of radioactivity are those from the decommissioning waste stream and that they are comparable with Sizewell-B wastes (the only operational PWR in the UK). Given the difficulty with obtaining extensive relevant data, and using the comparisons undertaken by us and RWM, we have concluded that the production of solid wastes from a UK ABWR is comparable to similar reactor types, and to those which have been submitted for GDA.	AR06 (Chapter 11)

Summary of points raised		Our consideration of the points raised	Also noted in:
		In addition to these comparisons, we have assessed Hitachi-GE's demonstration of use of best available techniques to minimise solid waste arisings from the UK ABWR during operation and decommissioning as detailed in our assessment reports on BAT (AR03) and solid waste and spent fuel (AR06).	
h	In response to consultation question 9 (dose), the respondent recognised that the radiological impact of discharges is low and that the resultant doses are well below any constraint. The respondent requested a layman's interpretation be given, for example an additional n% over natural background levels.	The expected doses to the public can be compared with background dose rate from natural sources of radioactivity. Natural background dose rates include cosmic rays, doses from naturally occurring radionuclides in foods, doses from rocks and soil and doses from radon gas. Natural background dose rates are affected by underlying geology which varies across the UK. Levels of radon gas also vary and make a big contribution to doses in parts of the UK. Natural dose rates range from 1.5 mSv/y to 8 mSv/y across the UK. The UK average is 2.2 mSv/y. In Wales, the dose rate has been assessed by county and ranges from 1.6 mSv/y in Mid Glamorgan to 3.0 mSv/y in Clwyd. In Gwynedd the dose is 2.8 mSv/y. In Gloucestershire (near Oldbury), the background dose is 2.5 mSv/y. The predicted doses from a UK ABWR are up to 0.025 mSv/y. This assessed dose is, therefore, below the dose constraint of 0.3 mSv/y and well below the range of background dose rates for the UK.	AR09 (Chapter 13)
i	In response to consultation question 15 (water abstraction), the respondent highlighted that the assumption of seawater cooling is not applicable to Oldbury and that cooling towers will be required. The respondent queried what impacts this would have on the generic design and whether this would result in any greater risk to people and environment?	The assessment of doses to the public provided by Hitachi-GE considered siting 1 ABWR at a generic site using direct sea water cooling, as it would be for Wylfa A. Discharges of liquid radioactive wastes have been modelled for the marine conditions around Wylfa. The Environment Agency made an independent assessment of doses to the public – for 1 ABWR sited at a generic site more representative of Oldbury. In the Environment Agency assessment, liquid discharges have been modelled for the Severn Estuary close to Oldbury.	A7.3 also see AR09 (Chapter 13)

Summary of points raised		Our consideration of the points raised	Also noted in:
		Doses from liquid discharges are very low for discharges to either the marine environment near Wylfa or the Severn Estuary near Oldbury. The doses are low because the liquid discharges are very low. Liquid discharges are low because most of the reactor water is recycled in the UK-ABWR design. The additional dispersion of mixing discharges in the large volume of cooling water discharges to the environment is not considered in the modelling for GDA, but will be considered at the site-specific stage. Allowing for cooling water discharges as part of the modelling may reduce the predicted doses by increasing the amount of dispersion.	
ABWR-07 Individual 3			
a	Concern was raised that the way information is presented is too technical and hard to read, making it hard for members of the public to be able to respond.	Assessment of nuclear power station designs is a complex and technical subject. It's important to us that we provide different levels of material to enable anyone to get involved and engage with our work. Our research with Sciencewise, before this consultation began, highlighted the work we are doing to improve public involvement in our nuclear new build regulation and assessments of reactor designs. For this consultation we provided a number of documents of varying levels of complexity: • technical assessment documents (specialist knowledge of nuclear industry needed to understand these documents) • consultation document (a mixture of technical info and summaries at the start of each chapter) • summary (aimed at a wide audience with some previous knowledge) • web copy and a briefing note – (aimed at a wide audience with some basic knowledge) • infographics – (straightforward information for those with no previous knowledge)	Chapter 2 - Consultation

Summary of points raised		Our consideration of the points raised	Also noted in:
		We follow a style guide which is provided by government for use by public bodies. We also worked with a plain English technical editor on all our documents to ensure that they complied with our Environment Agency style guide. Our national stakeholder event, and local briefings and drop-ins provided people with an opportunity to come along and ask the experts about what was written in the documents, particularly if they did not understand, wanted clarification or to challenge. We always welcome, where resources allow, opportunities to get out and meet stakeholders and communities to explain our work. We also encourage feedback from those who read the documents on readability and style so that we can work to improve future documents.	
ABWR-09 Oldbury-on-Severn Parish Council			
a	In response to consultation question 5, the respondent queried whether Hitachi-GE operates a lessons learned register to capture operational incidents and remedies from operating stations in Japan and worldwide? The respondent also queried whether Hitachi-GE will provide a formal technical service to operators throughout the lifecycle and are operators committed to take up such a service?	In GDA, Hitachi-GE prepared a pre-construction safety case (QGI-GD-0008) Chapter 4.4.1 which sets out how safety and environment will be managed throughout the plant lifecycle. It states: "Hitachi-GE will establish the organisation and system to support the Licensee and to implement effective safety, environment and security management over the entire Plant Lifecycle of UK ABWR, in order to achieve a high level of safety while maintaining configuration control and structural integrity of the plant design. Throughout the plant lifecycle, ultimate responsibility for safety rests with the Licensee who shall be supported by Hitachi-GE. However, Hitachi-GE has a key responsibility as Vendor, Constructor, Contractor and the enduring role of Responsible Designer. The most important aspect of safety management from a Hitachi-GE perspective is to harmonise the management arrangements between Hitachi-GE and the Licensee in an effective way so that the Licensee is able to fulfil the responsibility for safety in the nuclear power station. Safety in each phase of the Plant Lifecycle and the responsibility for activities affecting the environment are	A7.4 and AR01 (Chapter 5)

	Summary of points raised	Our consideration of the points raised	Also noted in:
		clarified in the coordinated management arrangements for both Hitachi-GE and the Licensee. During the GDA process, the coordination of the management system of Hitachi-GE and that of Licensee would be required with regard to procurement engineering activities related to Long Lead Items such as reactor pressure vessels and reactor containment vessels". It also states. "Hitachi-GE supports the Licensee in providing practical technical information required for preparing a site-specific PCSR and environmental report. Hitachi-GE will continue to assist the Licensee during the Plant Lifecycle, as required, to ensure that the Licensee is able to satisfy requirements for safety and the environment. In addition, Hitachi-GE can advise and support the Licensee during plant operation. Hitachi-GE is active in sharing operational experience and knowledge as well as knowledge gained from the electrical power industry in Japan and outside Japan, other designers / operators and non BWRs to help ensure lessons learned are taken account of in future projects". We expect organisations to learn from their own and others' experience so as to continually improve their ability to protect the environment, and this is clearly set out in our 'Radioactive Substances Regulatory Environmental Principles' document (Environment Agency, 2010). As stated in our consultation, the claims / arguments / evidence capture process support the safety and environment case and will ensure knowledge transfer to a future operator. We are confident that this includes learning from experience and that Hitachi-GE, in its role of responsible designer, will be able to support a future operator to maintain high standards of environmental protection for the UK ABWR.	
b	In response to consultation question 8, the respondent referred to H-3 and C-14 abatement. The respondent queried whether Hitachi-GE or any other organisation is	Ongoing research and development into tritium (H-3) prevention/abatement appears to be limited. Some examples are: • research into development of a tritium recovery system from Candu tritium	AR03 (Chapter 7) and AR04

Summary of points raised		Our consideration of the points raised	Also noted in:
	known to be actively researching or funding development of abatement for H-3 and C-14.	removal facility (China Academy of Engineering Physics, China; SC I.S. TECH SRL, Romania) • removal and recycling of tritium from fusion exhaust gases (JET – Culham Centre for Fusion Energy) • research into prevention of fuel cladding failure and release of tritium from failed fuel (Imperial College London funded by EPSCR and Ministry of Defence) • use of graphene filters to remove particulate and volatile radionuclides from waste streams (Nuclear Decommissioning Authority; Office for Nuclear Regulation) Ongoing research and development into carbon-14 abatement also appears to be limited. There is some wider research being undertaken into carbon capture, storage and reuse. There is also some research into the use of graphene filters for carbon-14 (Nuclear Decommissioning Authority; Office for Nuclear Regulation).	(Chapter 9)
c	In response to consultation question 9, the respondent commented that fuel pin failure assumes a single pin failure at any one time with rapid replacement. The respondent queried whether all relevant data for similar BWRs has been obtained and what the likelihood is of more than 1 fuel pin failing.	Operating experience (OPEX) related to the frequency of fuel pin failure and the discharges to the environment resulting from fuel pin failure was examined during our detailed assessment of the UK ABWR design for GDA. 2 or more fuel pins failing at the same time is not an event that is expected to occur under normal operation during the lifetime of the plant. ONR assesses events that occur outside of normal operation.	A7.4 And AR03 (Chapter 7)
d	In response to consultation question 9, the respondent noted that H-3 and C-14 discharges exceed the mean from existing BWRs. The respondent queried whether the relatively higher levels are a particular feature of Hitachi-GE's existing operational BWR designs. Furthermore, the respondent asked, if sufficient data is not available, what steps is Hitachi-GE taking to obtain the data, and whether there is likely to be any impact	Hitachi-GE provided a response to RQ-ABWR-1117 explaining the conservatisms of the approach used to derive carbon-14 and tritium (H-3) discharge estimates. It is expected that the actual gaseous discharges of carbon-14 and tritium will be lower than the estimates. Any impacts of carbon-14 discharges on radiocarbon dating technology that may be used for relics from archaeological sites was not considered as part of our GDA assessment.	A7.3 and AR04 (Chapter 9)

Summary of points raised		Our consideration of the points raised	Also noted in:
	of the discharges of C-14 on radiocarbon dating technology that may be used for relics from archaeological sites in the vicinity of the plant such as exist at Oldbury-on-Severn.		
e	In response to consultation question 12, comment was made that the monitoring systems for aqueous wastes will need to be reviewed for Oldbury-on-Severn with a hybrid cooling water system.	This is a site-specific issue outside the scope of GDA. However, the monitoring requirements would be reviewed during site-specific permitting to ensure that all discharge routes which are assessed to require permit limits are appropriately monitored. Consultation will take place as part of this process.	A7.3 and AR07 (Chapter 12)
f	In response to consultation question 13, comment was made that the estimates on radiation dose impacts would seem to require considerable reworking for an actual site.	The estimated doses would be reassessed if/when an application for a permit for a nuclear power station is made. The assessment will be based on site-specific parameters. The modelling of doses in GDA is designed to take into account the expected environmental settings (the 'generic site') where a power station might be sited. The assessment is conservative, in that it maximises the estimate of doses. Hitachi-GE defined the generic site as similar to the environment around Wylfa and made its assessment. The Environment Agency used a generic site that is based on the Oldbury site. At Oldbury, dispersion in the local aquatic environment is more limited than around Wylfa. This means that the initial environmental dispersion of liquids around the Oldbury site is much less than around the Wylfa site. Liquid discharges from the UK ABWR are very small due to the waste water recycling and re-use system. The impact of the discharges has been assessed to be less than 1 µSv/y, for either discharges made around Oldbury or for discharges made around Wylfa.	A7.3 also see AR09 (Chapter 13)
g	In response to consultation question 14 (RSR permitting), the respondent commented that the short-duration release of up to 0.02 µSv in Table 13.2 seems to be from a single fuel pin failure having effect for 24 hours. Concern was raised that if more than 1 fuel pin fails and/or repair times are longer	A failed fuel pin may take longer than 24 hours to isolate and/or replace. Hitachi-GE states that this process may take up to 14 days (in its GDA submission). For assessment of doses arising from short-term releases, Hitachi-GE assumed that all discharges resulting from a single fuel pin failure over 14 days were released in 24 hours. This is very conservative, and ensures that the short-term release dose	AR06 (Chapter 11) and A7.4

Summary of points raised		Our consideration of the points raised	Also noted in:
	than 24 hours, which seems possible, then this is an underestimate and, although highly unlikely to raise potential dosages to the public above recommended levels, should be replaced by a worst case estimate.	assessment does not result in an underestimate. We know from the fuel pin failure data supporting the expected events definition that a single fuel pin failure is feasible within the operational lifetime of the plant and is, therefore, included in the expected discharges for normal operations. The probability of multiple fuel pin failure is so low it makes this event fall outside normal operations and this is, therefore, considered by ONR.	
h	In response to question 16, comment was made as to the cooling water requirements and it was queried whether thought has been given to recovering a large amount of low-grade heat, particularly from a hybrid cooling system, and whether best available techniques are being employed here. It was also queried whether consideration has been given to the use of electro-chlorinators to create biocidal cooling water as they are easily controllable and largely avoid HSSE issues associated with the storage and handling of sodium hypochlorite and is best available techniques being employed here.	For the purposes of the GDA, the design is based on once-through cooling for the generic site and we accept this as the best available technique for a coastal site. Hitachi-GE has determined that 2,581 MW of waste heat will be generated from the cooling water systems with a mean temperature of 23 °C. This is regarded as low-grade heat and limits the recovery and application. Information has been provided on a number of options for using the beneficial waste heat, including crop growing (glasshouses), aquaculture (fish farming), road and airport runway de-icing, algae bio-diesel growth, desalination and district heating. Each of these options has been considered in turn and the practicalities and limitations of implementation have been discussed. No option is readily viable for the waste heat from the UK ABWR. At the site-specific stage, a future operator will need to demonstrate that the chosen cooling system represents the best available technique. We acknowledge that for an estuarine site alternative cooling systems, for example hybrid cooling may be considered as the best available technique or electro-chlorinators may be considered.	AR11 (Chapter 17)
i	In response to question 17, comment was made that the title 'Operation of installations' implies overall operation which should include the maintenance of items including those within the nuclear	For the purposes of GDA the 'Operation of Installations' covers the non-nuclear combustion plant (diesel generators and auxiliary boilers) that provide back-up electricity and conventionally generated steam. The GDA process assesses whether the combustion plant requires an installation	A7.4 and AR11 (Chapter 17)

Summary of points raised		Our consideration of the points raised	Also noted in:
	operating envelope such as reactors, steam turbines and multiple items of ancillary equipment. The respondent noted that maintenance activities and their resulting emissions are not excluded from the GDA scope and therefore not automatically designated for site-specific permitting in Appendix 6 of the Consultation Document and therefore queried where such aspects will be assessed. The respondent also queried why the use of diesel fuel systems, for boilers and emergency generators, is considered a best available technique when there are lower-emission alternatives using natural gas (or liquefied natural gas in case of no nearby gas supply pipeline.)	environmental permit under EPR16 and, if so, whether we are likely to grant a permit based on the environmental impact from the combustion plant. The installation environmental permit is a separate permit to the radioactive substances environmental permit and both would be required by an operator at the site-specific stage, along with a Nuclear Site Licence, which would be issued by ONR. Radioactive emissions associated with the reactors and steam turbines, along with maintenance of these facilities, would be covered by the radioactive substances permit (and Nuclear Site Licence). Emissions from the combustion plant and maintenance of the equipment would be covered by the installations environmental permit. A future operator would have to apply for both permits at the site-specific stage, and we would only issue the permits if the management arrangements and environmental impacts were acceptable. The auxiliary boilers and emergency generators are required for nuclear safety and need to respond when called upon. One of the key considerations for this is the availability of supply. Although lower emission alternatives such as natural gas are available, on-site diesel fuel storage provides a more robust supply when compared to natural gas. The final choice of the fuel for the auxiliary boilers and emergency generators is a site-specific issue and is for a future operator to decide, taking into consideration nuclear safety requirements.	
j	In response to question 18, comment was made that it seems likely that operators will seek site-specific permitting for 2 or more reactor units and therefore queried whether the sites would become lower tier COMAH establishments on permit award due to the quantities of diesel fuel planned to be stored on site or only when the second reactor was built.	This is a site-specific issue and out of scope of GDA. It should be noted, however, that the COMAH Regulations apply once the amount of the dangerous substance exceeds the relevant qualifying threshold. For diesel, based on the information provided during the GDA, this would be when the oil was brought on site for the second reactor. If 2 or more reactors were planned, we would expect a prudent operator to notify us at the site-specific permit application stage that they expect to be subject to COMAH Regulations.	A7.3 also see Chapter 18

Summary of points raised		Our consideration of the points raised	Also noted in:
ABWR-11 Action Against Nuclear			
a	The respondent raised concern over unexplained cancer clusters on both sides of the River Severn during the active periods of nuclear power and are concerned about future cancer risks.	The Environment Agency passed this consultation response to Public Health England for specialist advice. The response from Public Health England is set out below. Response from Public Health England: In the United Kingdom scientific evidence of possible links between cancer incidence and emissions from nuclear facilities are regularly reviewed by the Committee on Medical Aspects of Radiation in the Environment (COMARE). COMARE is an expert body of the Department of Health established in November 1985 on the recommendation of a public enquiry set up to investigate possible links between cancer incidence and the Sellafield and Dounreay nuclear installations. Over the years COMARE also reviewed evidence on the incidence of childhood leukaemia in the vicinity of nuclear power plants in Great Britain, including those situated on the Severn Estuary, following the publication of a number of studies in Germany and other countries. The review, published in 2011 as COMARE Report 14 (COMARE, 2011a), considered causes of childhood leukaemia and potential relationships to leukaemia around nuclear sites and found no evidence which suggests that there is an increased risk of childhood leukaemia and other cancers in the vicinity of nuclear power plants due to radiation effects. The report recommended the continuation of initiatives into leukaemia and cancer research to identify the causative mechanisms for childhood leukaemia. COMARE continues to examine new evidence of possible links between cancer and discharges from nuclear installations. Its most recent report (COMARE, 2011b) contained an updated review of the incidence of childhood leukaemia and other cancers around the Sellafield and Dounreay nuclear installations. In it, COMARE concluded that “the absence of correlation between the incidence rates of leukaemia and non-Hodgkin lymphoma predicted on the basis of assessed radiation doses and the observed incidence rates at 3 different	A7.3 A7.4 see also AR09 (Chapter 13)

Summary of points raised		Our consideration of the points raised	Also noted in:
		nuclear sites further supports the conclusion that radiation cannot be a major causal factor in these areas.” Public Health England provides authoritative advice to government departments, regulatory agencies and the general public on radiation protection and more specifically on the health effects associated with the use of radiation in industry, medical sector and research. Public Health England regularly reviews scientific evidence on the possible link between childhood leukaemia and other cancers due to emissions from nuclear power plants. Any query or concerns that members of the public may have in relation to the potential health effects associated with radiation can be addressed directly to Public Health England. It should be noted that doses arising from routine discharges from the nuclear industry are very tightly controlled by appropriate regulation to ensure that they are within legal limits which are set according to international standards. Limits on discharges of radionuclides for new nuclear plants will be set by the Environment Agency or Natural Resources Wales as appropriate as part of the permitting process. The limits are set conservatively to ensure that doses to the public are below the national dose constraints and the dose limits.	
b	The respondent commented that they are a small group who at the last minute have become aware of the development plans and requested that senior management arrange a public meeting in Lydney to discuss further. The respondent note that they anticipate at least 300 people wanting to attend a public meeting.	Before our consultation began we asked local councils and organisations how they wanted to be involved in our consultation and published a high level engagement plan on our website. We believe that the level of local engagement was proportionate for our assessment of this design. We have added the respondent's details to our stakeholder database and will keep them informed about our regulation of any future nuclear development in the vicinity of Lydney, for example at the Oldbury site. The permitting process allows for further consultation to take place.	Chapter 2 - Consultation
ABWR-13 Individual 6			
a	Comment was made that the consultation was poorly	In England the consultation and local events were advertised in a number of local	Chapter 2 - Consultation

Summary of points raised		Our consideration of the points raised	Also noted in:
	advertised and that the respondent only knew about it through a news item online and a Facebook post. The respondent highlighted that they were pleased that the consultation meeting was conducted in Welsh, their native tongue. The respondent highlighted that the consultation event should have been accessible to more people by more intensive advertising and a presentation at a more central location.	newspapers, on posters and social media. When we launched the consultation we issued a press release to national and local media and published a number of webpages. This information was also shared through social media. The environmental regulators and ONR all use different channels and approaches for communications and engagement. We work together and learn from each other. In Wales, we did not advertise, but relied on our social media communications and local posters. We also requested that third parties assisted in raising awareness. We are conscious that this was not wholly successful and we have included it in our lessons learnt assessment and will take note of this as part of planning for future consultation events such as any specific ones for a site in Wales. 1 stakeholder event was held as part of the Horizon Public Liaison Group (PLG). As such, Natural Resources Wales, the Environment Agency and ONR attended the PLG at their usual meeting place. The PLG allowed us to invite other stakeholders to the event and representative invites were issued to an extensive list of stakeholders and to various groups. In addition, some members of the public requested attendance and were encouraged to attend.	
b	The respondent objected to any future nuclear development in the whole of the UK, however appreciated that this is a government decision and therefore regulators are tasked with considering the ramifications.	The principle of future nuclear development as a whole is a matter of government policy and is outside the scope of GDA. The Environment Agency, Natural Resources Wales and ONR are involved in the scrutiny and assessment of any nuclear reactor designs that are proposed for use in the UK and we will scrutinise any developments in accordance with our regulatory remit.	A7.3
c	The respondent observed that the illustration of the cross section of a box in a green field failed to show any chimney or outlet pipe for the steam containing tritium and other chemicals that will be discharged into the	The illustration used on the cover of our consultation document and assessment reports was supplied to us by Hitachi-GE. It's a high-level conceptual early illustration and is not reflective of the site-specific plans. We acknowledge that it does not show detail.	N/A

	Summary of points raised	Our consideration of the points raised	Also noted in:
	atmosphere. A comment was also made that there is nothing to show that effluent will also be discharged into the sea.	You can find more detailed drawings on both Horizon Nuclear Power and Hitachi-GE websites.	
d	The respondent noted presentations at the consultation event indicated that prospective discharges represented sufficiently small doses to pose no threat to human life and unlikely to harm wildlife. Concern was raised that the project should not be allowed to continue without the certainty that the complete range of biodiversity is in no danger. The respondent also queried how the toxicity of these emissions can be assessed when no such reactors are currently in operation, with those in Japan remaining closed after Fukushima.	An assessment has been made of the radiological effect of the discharges on the environment. This assessment gives an indication of the toxic effects of the discharges. The radiological impact was assessed by determining which radionuclides will be present in the discharges and how much of each radionuclide is present, see our assessment reports AR4 and AR5 (Environment Agency, 2017d and 2017e) for gaseous and aqueous discharges. The levels in the environment following the discharge can be predicted using information on how dispersive the environment is and the expected behaviour of each radioelement. The relative toxicity of each radionuclide is factored in using information on the biological behaviour of the element, the radioactive half-life and the types of radioactive emission. Further information on how this is modelled is included in our assessment report AR10 (Environment Agency, 2017j) on non-human dose. For generic design assessment, a generic dose assessment is undertaken to assess the impact of proposed discharges on wildlife. The full range of UK species is not assessed individually. If an application is made for a site-specific permit the environmental regulators will consider the impact on flora, fauna and habitats at that time. This will include a site-specific assessment of the impact of radiological discharges on wildlife and will assess any impact on wildlife in designated wildlife sites near the proposed location of the power station. The applicant must submit a Habitat Regulations Assessment to the regulators for consideration as part of their applications for environmental permits.	AR10 (Chapter 13) Also AR4, AR5
e	The respondent was unsatisfied by Horizon Nuclear Power failing to provide a representative with adequate technical knowledge, who was	Natural Resources Wales and the Environment Agency provided representatives with expert technical knowledge of the environmental assessment process and technical findings that Natural	Chapter 2 - Consultation and

Summary of points raised		Our consideration of the points raised	Also noted in:
	unable to answer some of the questions posed at the evening meeting. The respondent noted that this reflected their long held belief that Horizon's consultations are merely box ticking exercises and no amount of objecting will stem their progress.	Resources Wales and the Environment Agency conducted for our assessment of the Hitachi-GE generic reactor design. We are aware that the technical representative who was expecting to be present at the stakeholder engagement meeting was unable to attend due to a family bereavement and were pleased that Hitachi-GE were able to provide a stand in at short notice. We cannot comment on the suitability of the representatives from Horizon Nuclear Power as this is beyond our control. We have passed this comment to Horizon Nuclear Power for its consideration and we would suggest you raise this directly with them if you have any concerns. We understand Horizon Nuclear Power conducts regular public consultation and engagement meetings and we would encourage the public to attend these and discuss any issues regards its proposal with them directly. We note that Horizon Nuclear Power is not the decision maker on permits or planning applications and independent consultations will also be carried out at that time.	A9.4
ABWR-14 Individual 7			
a	Concern was raised that the consultation on preliminary conclusions is a foregone conclusion and that it is crafted to prepare the ground for Natural Resources Wales to issue a statement of design acceptance (SoDA) on Hitachi-GE's UK ABWR design. Comment was also made that the Office for Nuclear Regulation (ONR) is similarly engaged in paving the way for a design acceptance confirmation (DAC) on the UK ABWR and that this paves the way for Development Consent Order (DCO) and construction at any EN-6 site, other brownfield or greenfield site. The respondent raised a large number of criticisms with	We have deliberately made the GDA process open, transparent and consultative. Before this consultation, we did not make any final decisions, and did not do so until after we had carefully considered all the responses. The decisions by the regulators are independent of government and the requesting party, and there is firmly no expectation that regulators will simply accept and approve a design if they have demonstrable and justified reasons not to. The Environment Agency and Natural Resources Wales designed their GDA process to reflect as closely as possible their normal processes for applications for nuclear site permits. Consultation is normal practice for the Environment Agency and Natural Resources Wales when dealing with applications for nuclear site permits. Our approach to consultation is in line with the government's published consultation principles. At the start of the assessment of	Chapter 2 - Consultation

Summary of points raised		Our consideration of the points raised	Also noted in:
	Natural Resources Wales' and the Environment Agency's public engagement process, with specific criticisms of the types of presentations given, venues and invitees.	the UK ABWR we published a document setting out our high-level approach to engagement It reflects our principle of 'working with others'. We believe that 'by working closely with and listening to partners and communities, we can improve the environment, protect more people and promote sustainable growth. We make better decisions when we take account of local opinions and draw upon the diverse strengths of others.' We need to be proportionate in deciding when and how we engage. We recognise that in different situations different levels of engagement are needed. Before our consultation began we talked to national stakeholders and local representatives about how they wanted to be involved in our process. They provided feedback about their communities and the channels they use to read information and their preferred methods of engagement. We published our high level engagement plan on our website. We set out our objectives for consultation. We wanted to make sure that stakeholders: • understand how we assessed the reactor design • understand the findings of our assessment • have an opportunity to give us their views • know what will happen next • can help make our final decision on the acceptability of the reactor design as robust as possible Further information about what we did in this consultation is included in this decision document in Chapter 2. Comments process - In addition to formal consultation, GDA includes a continuous 'comments process' for people to ask questions and receive a response. During our assessment process comments could be made about the UK ABWR design via Hitachi-GE's website. The process opened on 6 January 2014 and continued throughout GDA until 15 August 2017. Hitachi-GE received and responded to 83	

Summary of points raised		Our consideration of the points raised	Also noted in:
		comments. We saw the questions and responses and used them, where relevant, to help inform our assessments. Site-specific consultations - There would be further opportunities for engagement and input into our decision making process if/when Horizon Nuclear Power applies for environmental permits from Natural Resources Wales (Wylfa Newydd) and the Environment Agency (Oldbury). Evaluation is important to us and enables us to learn lessons and share our experiences with others. The outputs and outcomes from our communications and engagement activity is evaluated internally in line with the Government Communications Services evaluation framework. Our GDA consultations are also evaluated by an external and independent organisation. The evaluation of this consultation will be published in spring 2018.	
b	Comment was made that the consultation process is frustrated by the public not having access to specialists to help them give a meaningful response to the consultation questions.	Our regulators are independent of government and Hitachi-GE. Their specialist knowledge was available to the public throughout the consultation and ongoing comments process. We held public events during consultation where our technical experts were available and accessible to answer questions. We also provided contact details in our documents, encouraging and enabling the public to get in touch with us and ask about the information we were consulting on. We actively engage with nuclear academics, professional institutions and NGOs who have a high level of technical knowledge and understanding of the design and our assessment conclusions. All of these groups responded to the consultation. They also took part in the GDA comments process.	Chapter 2 - Consultation
c	The respondent was critical of the manner in which Natural Resources Wales consulted on the GDA assessment of the UK	Natural Resources Wales worked with the Environment Agency and followed the same consultation plan as this was an England and Wales joint environmental regulator	Chapter 2 - Consultation

Summary of points raised		Our consideration of the points raised	Also noted in:
	ABWR, stating that the process seems flawed and that Natural Resources Wales should launch a fresh round of express engagements directly with the public in Wales. The respondent stated that Natural Resources Wales should engage directly with all potentially affected communities in towns and villages across North Wales. The respondent requested that such a consultation should include communities likely to be affected under varying dispersion footprints of routine radioactive discharges, and those under fallout footprints in the event of accident or containment breach involving the proposed new reactors, or the on-site spent nuclear fuel stores, at Wylfa.	consultation for our draft findings of a generic design (as opposed to a site-specific plan for England or Wales). This included a variety of means, including online consultation, direct mailing, stakeholder events and local drop-ins. In addition, press releases were produced, which were used by several media and newspaper outlets. If Natural Resources Wales receives site-specific Wylfa Newydd permitting applications, the consultation events associated with our consideration of this application will provide further opportunity for the general public to provide comments on site-specific matters, whilst taking into account the lessons learned from previous consultations.	
d	Request was made for Natural Resources Wales to prepare and present estimated doses for the population in Wales from a UK ABWR based on a Welsh generic site, as well as dispersion charts for routine and abnormal radioactive discharges. Comment was made that such data should be provided to the public directly.	This consultation was for the Natural Resources Wales and Environment Agency draft decision about the generic reactor design for England and Wales. It is not a site-specific design. However a nuclear operator (Horizon Nuclear Power) is proposing to use the design (if approved by regulators) at 2 sites, 1 at Wylfa in Wales and 1 at Oldbury in England. The generic design provided to Natural Resources Wales and the Environment Agency includes estimated doses based on a generic design as this GDA is for a non-specific generic site. We have conducted our own assessments of the estimated doses and have published these in the assessment reports. In addition, we arranged to have the estimated doses provided by Hitachi-GE independently assessed, the results of which are also provided. If we receive any applications from an operator for environmental permits to operate with respect to a site in Wales, we shall undertake a rigorous permit application determination process. This will include an	A7.3 and AR09 (Chapter 13)

Summary of points raised		Our consideration of the points raised	Also noted in:
		assessment of site-specific estimated doses presented by an applicant. This information will be made publicly available by the applicant as part of the process. We will also provide the results of our own assessments of the estimated dose as part of our decision. We shall also publicly consult on our draft decision.	
e	The respondent noted that Wales has a legal duty on sustainable development and stated that, in order to facilitate effective public participation in environmental decision making, Natural Resources Wales should establish a ring fenced community fund for the public in affected local communities across North Wales in particular.	Part of Natural Resources Wales' role is to regulate the environmental aspects of any new nuclear power station in Wales. Natural Resources Wales must also take into consideration the wellbeing objectives set out in the Well-being of Future Generations Act 2015 and will do so at the permit application stage. However it is not either our role or within our control to establish such a fund, which would be a consideration under the planning process. In terms of funding we would suggest you raise this with the appropriate developer (in Wylfa Newydd's case, it is Horizon Nuclear Power) and with the Secretary of State through the Development Consent Order process.	A7.4
f	A request was made for Natural Resources Wales to convene public hearings in all the regions in Wales to review the entire community feedback on the draft proposed SoDA, prior to finalising the SoDA.	As part of the GDA process, this report provides our responses to all the community feedback that we have formally received as part of the consultation process. This information is made freely available to the public. We believe that the level of local engagement was proportionate for our assessment of this design. We are confident that we did all we should do to properly consult and that this consultation was accessible to, and clearly targeted at, the people and organisations it was intended for. We are grateful to all who took the time to contribute and to attend our consultation events in both England and Wales. If we receive any applications for environmental permits with respect to the Wylfa Newydd development, we shall initiate further public consultations.	Chapter 2 and A7.2
ABWR-15 Anglesey County Council			
a	The respondent seek reassurance that the technology will be safe, and additional safeguards will be	We will only issue a SoDA or iSoDA if we are convinced that the design will provide for adequate protection for people and the environment, in relation to those matters for	A7.4

Summary of points raised		Our consideration of the points raised	Also noted in:
	employed by way of improvement over previous technology. Comment was made for GDA documents to be clearer on what specific improvements have been incorporated into the UK ABWR design.	which we are responsible. Further assessment will be undertaken at the site-specific application stage when further information will be provided and additional consultation undertaken. We expect operators to continue to improve designs by applying best available techniques. As part of the GDA process, the requesting party must demonstrate that the proposed design applies the best available techniques, and this will be considered further as part of any site-specific application that may follow. With regards to historical changes to the ABWR design, these are detailed in material provided by Hitachi-GE on its website, such as in the pre-construction safety report. Specifically, developments of the design are also detailed in a document entitled Genesis of ABWR Design.	
b	The respondent queried why Public Health England (PHE) recommend a dose constraint of 150 µSv/y, half that of the current UK constraint of 300 µSv/y for any new source. Furthermore, comment was made that the public will be unfamiliar with the dose units and could benefit from a comparison with other sources of ionising radiation (preferably Anglesey specific).	The Environment Agency has passed this consultation response to Public Health England as it falls within their remit. The response from Public Health England is detailed below. Response from Public Health England: The recommendation from PHE that a dose constraint of 150 µSv/y should apply to new nuclear power plants and disposal facilities for radioactive waste was included in the response to the 2007 ICRP recommendations (ICRP, 2007) and in the advice on radiological protection objectives. Both of these documents were published by the Health Protection Agency, a precursor to Public Health England (HPA, 2009a and HPA, 2009b). In its recommendation the HPA noted that the dose constraint of 0.3 mSv/y should be considered a maximum value and advised the UK government that a more challenging dose constraint of 150 µSv/y should be set for new NPPs and waste disposal facilities since measures to reduce dose are easier to take at the design stage. This advice took account of uncertainties in the understanding of some non-cancer related health effects and reflected a very prudent view that the overall radiation risk factor may increase due to	A7.4

Summary of points raised		Our consideration of the points raised	Also noted in:
		these non-cancer effects. In the years since the publication of the HPA advice, no scientific evidence on the risks of non-cancer health effects has emerged that warrants the reduction of the dose constraint from 300 μSv/y to 150 μSv/y. In addition the application of the optimisation principle and more in particular of 'best available techniques' (BAT) by the Environment Agency as part of its permitting procedures results in the setting of discharge limits corresponding to doses which are much lower than the dose constraints recommended by PHE. As a consequence PHE is now of the opinion that there is currently no need to specify a lower dose constraint of 150 μSv/y for new nuclear power plants and radioactive waste management facilities and that the dose constraint of 300 μSv/y, which applies to existing nuclear facilities, should be retained for new nuclear facilities. PHE continues to emphasise that optimisation of planned releases during the operational phase of nuclear facilities should be the most appropriate process to ensure that doses are kept as low as reasonably achievable. It also considers that the dose constraint is very useful tool in the optimisation process which is associated with a single source and should not be interpreted as a dose limit. PHE continues to recommend that the dose constraint of 300 μSv/y should be regarded as the value below which it should be planned to keep all doses, but that economic and social factors should be considered when selecting dose constraints for particular installations. Response from the Environment Agency: In terms of a comparison with the background dose rate from natural sources of radioactivity, see our response to ABWR-05h.	
c	The respondent noted that reference is made to a stack and yet neither Fig 8.1 or 3.1 or the front of the document show a stack and request that this is	The illustration used on the cover of our documents was provided to us by Hitachi-GE. It's a high-level conceptual early illustration and is not reflective of the site-specific plans. We acknowledge that it does not show detail.	N/A

Summary of points raised		Our consideration of the points raised	Also noted in:
	reflected on future diagrams / consultations.	You can find more detailed drawings on both Horizon Nuclear Power and Hitachi-GE websites. We expect that any site-specific applications will include illustrations reflective of the actual site-specific design and layout.	
d	The respondent noted that auxiliary boilers and emergency diesel generators may affect local air quality and that plans for Wylfa Newydd have considerably larger thermal outputs than those given in paragraph 546 of the consultation document. Comment was made that, although the respondent accept that the design may differ, they hope that design changes are fed to relevant regulators at the earliest opportunity.	This is a site-specific issue and is out of scope of GDA. It should be noted, however, that the auxiliary boilers and emergency diesel generators form the main combustion plant for the UK ABWR. A future operator will need to apply for an installations environmental permit to operate the combustion plant. As part of the permit application a future operator would need to identify the thermal input of the combustion plant and also demonstrate that the environmental impact from the combustion plant was acceptable. This process ensures that any changes from the combustion plant design covered by the GDA are captured and assessed.	A7.3 and AR11 (Chapter 17)
e	Support was given to the conclusions on the process used to identify best available techniques to minimise waste and discharges.	Support stated in this response has been noted.	AR03 (Chapter 7)
ABWR-16 Lissajous Nucleonics Ltd.			
a	The respondent commented that the GDA position on fuel storage and disposal (as described at the Birmingham GDA consultation event on the 24 January 2016) does not accurately reflect the conclusion given in the reprocessing section (page 116) of the Government White Paper on nuclear power published in 2008. The respondent was concerned that GDA is placing an unnecessary restriction on any future government's response to reprocessing proposals, which might be made at some time during the period of interim onsite storage of the spent fuel.	In GDA, a once-through nuclear fuel cycle is assumed. This is consistent with government policy as stated in the White Paper on Nuclear Power (BERR, 2008). The White Paper does leave scope for consideration of a future proposal to reprocess spent fuel, however, no such proposal was submitted by Hitachi-GE for the UK ABWR. Hitachi-GE's proposed interim storage of spent nuclear fuel, until the availability of a future geological disposal facility (GDF) is, therefore, appropriate for GDA and consistent with government policy.	A7.3

Summary of points raised		Our consideration of the points raised	Also noted in:
	The respondent commented that that GDA should take into account the possibility that during the period of interim storage proposals may be made by nuclear consortia or indeed a government of the day to reprocess the onsite fuel. The respondent queried whether (in considering interim storage of spent fuel) the GDA process should ensure that all spent fuel discharged from a UK ABWR be packaged in a form and maintained in a condition suitable for reprocessing if, as the White Paper says, "…such proposals come forward in the future."		
ABWR-19 Individual 10			
a	A query was raised around how many million terabecquerels MTBq of spent fuel, that is nuclear waste, would have accumulated in the interim store at Wylfa after 60 years? A request was made to give this figure as a percentage of the maximum ever at Sellafield and whether the figure is around 40 MTBq? A related query was whether this figure is nearly 50% of the legacy spent fuel and wastes stored at Sellafield?	We have reviewed publicly available information and cannot provide the total activity in terms of TBq. However, Hitachi-GE has estimated that a UK ABWR would generate 9,600 fuel assemblies during a 60 year operational lifetime. It is difficult to compare waste arisings from different types of facilities. However in its generic design assessment, Radioactive Waste Management Ltd (RWM Ltd, 2016b) has compared the activity in a proposed UK ABWR spent fuel package to that from Sizewell B (the UK's only operating PWR). RWM Ltd concluded that the radionuclide inventories for UK ABWR and Sizewell-B fuel are similar. Data on the waste arisings at Sellafield can be found in the UK Radioactive Waste Inventory	AR06 (Chapter 11)
ABWR-20 Eleven Individuals			
a	The respondents believe that the nuclear industry as a whole is founded on lies and that Horizon is perpetuating these lies by assuring us that the ABWR is well proven to be safe, despite the evidence from Fukushima. Why are Horizon allowed to lie?	The nuclear regulators (ONR, the Environment Agency and Natural Resources Wales) have specific regulatory roles to assess any new reactor designs proposed for use in England and Wales. This includes an evaluation of the proposed design and any existing history and current operational performance of such design(s). Furthermore, the regulators also have	N/A

Summary of points raised		Our consideration of the points raised	Also noted in:
		specific roles to assess and regulate permits, licences and permissions for any new site-specific nuclear projects. We collectively undertake rigorous independent technical scrutiny and assessments of reactor designs in the generic design assessment phase and any subsequent site-specific proposals. If the regulators accept the design and are tasked with evaluating a site-specific proposal, we conduct another stringent assessment of the site-specific matters relating to using the design at a site location. If we issue permissions such as environmental permits, we set clear and stringent conditions, controls and limits on any nuclear operator, which we regulate compliance against as with any industrial activity we regulate.	
b	Comment was made that as nuclear reactor design is a very specialist subject, and that Natural Resources Wales is an underfunded and understaffed quango made up of agencies not related in any way to nuclear, are the respondents to assume that "generic assessment" workshops are "box ticking" exercises which will hand over submissions to government appointed experts?	Natural Resources Wales works extremely closely with our nuclear regulatory partners ONR and the Environment Agency. All 3 organisations are nuclear regulators, required by law to regulate existing and future nuclear industrial installations. All 3 organisations employ a variety of technical specialists across many disciplines and work areas applicable to the design, planning, construction, operation and decommissioning of a nuclear power station. In terms of resources, Natural Resources Wales regulates the 3 nuclear sites in Wales and works closely with ONR and the Environment Agency. The Environment Agency has larger numbers of nuclear specialists employed which is reflective of the larger number of nuclear establishments that they need to regulate in England compared to the 3 Natural Resources Wales currently have in Wales. As part of Natural Resources Wales' close working relationship with the Environment Agency, we have a service level working agreement, whereby the Environment Agency provides technical support to Natural Resources Wales for some specific topic areas. The generic assessment is not a tick boxing exercise but rather an intensive 4-year assessment programme involving considerable and exhaustive scrutiny by specialists from all 3 regulators to closely	N/A

Summary of points raised		Our consideration of the points raised	Also noted in:
		evaluate the proposed design for safety, security and environment. This precedes any site-specific proposals that a developer may put forward to the authorities. The regulators are independent of government and make their own decisions on the acceptability of new nuclear power station designs. The regulators carry out robust assessments of new nuclear power stations, challenging the information provided by designers and will only agree to issue a SoDA if they are content that a design is acceptable.	
c	A query was raised whether government appointed experts will be from establishments with "conflicts of interests" or whether the opinion of independent experts (who do not agree with the pro-nuclear establishment narrative view) will be heard?	The environmental regulators (Environment Agency and Natural Resources Wales) along with ONR collectively undertake rigorous independent technical scrutiny and assessments of reactor designs in the generic design assessment phase and any subsequent site-specific application. As part of GDA, the regulators, based upon the evidence provided, including consultation responses, reach decisions on whether to issue a SoDA and DAC. Our regulators and their decisions are independent of government, Hitachi-GE and any prospective applicant for a site-specific permit. As part of the GDA and site-specific permitting process, we undertake our own independent assessments of the estimated radiological doses to help inform our decision and to compare against assessments presented by the applicant. This consultation process and the comments process hosted by the Requesting Party's website provides an opportunity for all to provide us with their opinion and comments. We carefully consider all of the responses we receive before we make our decisions.	N/A
d	The response concluded by stating that the complete exercise of the "generic assessment" meetings have been non democratic in the way they have been organised. The respondents commented that public notices have not been carried out correctly and	See response to ABWR-14 (a). In terms of the development of nuclear power, it is government policy to use nuclear energy as part of the energy supply mix in the UK. Part of our statutory obligations and legal vires is to assess any new nuclear designs and site developments proposed, and regulate them via a prescriptive set of	A7.3 and Chapter 2 - Consultation

Summary of points raised		Our consideration of the points raised	Also noted in:
	that some are carried out behind closed doors to an invited list. The respondents consider that this type of unacceptable attitude has been experienced in the past by other government departments dealing with the proposed Wylfa Newydd project. The respondents stated that nuclear power is undesirable, unaffordable, and, with advancements in renewable technology, unnecessary.	regulatory tools including permits and licenses. This includes our GDA process.	
ABWR-21 Individual 11			
a	The respondent attended a drop-in event for Oldbury and found the information to be helpful and clear. The respondent commented that feedback would be read by the ONR and queried whether both the Environment Agency and ONR will receive the consultation response letter and process the comments.	All responses received have had all personal data removed (due to data protection requirements) and have been published on the GOV.UK website. Where points have been raised that lie within another organisation's remit, we have then sent a formal letter to that organisation with references to the relevant responses asking that the points made are given due consideration.	N/A
ABWR-22 Individual 12			
a	This respondent commented that in the run up to the decision to build a Pressurised Water Reactor (PWR) at Sizewell the Central Electricity Generating Board (CEGB) carried out a design review of all candidate technologies. The respondent noted that 1 of the conclusions of this review was that the BWR did not have sufficient barriers to prevent radioactive fission products from failed fuel cladding from being transported in steam, through the turbine and released to the atmosphere via the condenser off gas system. The respondent believes that the lack of a physical barrier to prevent fission products passing through the turbine is a	The ABWR is a development of the existing BWR technology. Since the assessment of technology for the Sizewell site, there has been continual development and improvement undertaken by the designers. These are summarised in the pre-construction safety report published on the Hitachi-GE GDA website. The off-gas treatment system has been demonstrated to be BAT and would be effective for capture of particulates, decay of noble gas fission products and capture of iodine radionuclides. In addition, over time there will have been improvements in fuel manufacture processes and associated fuel failure rates will have reduced. In GDA, the regulators assess each new power station design on its merits, considering current international and UK	A7.4

Summary of points raised		Our consideration of the points raised	Also noted in:
	reason why the ABWR should be refused GDA approval.	legislation and regulatory requirements and expectations.	
ABWR-25 Individual 15			
a	In response to consultation question 5 (management systems), the respondent stated that these were 'All good points'.	Consultation response noted.	N/A
b	In response to question 12 (monitoring of discharges), comment was made that all discharges should be monitored.	Discharge routes requiring permit limits will be monitored as detailed in our assessment report on sampling and monitoring (AR07).	AR07 (Chapter 12)
c	In response to question 14, (on radioactive substance permitting) the respondent commented 'As long as environmental monitoring is carried out'.	Requirements for an environmental monitoring programme will be addressed at site-specific permitting.	AR07 (Chapter 12)
d	In response to question 18 (Control of Major Accident Hazards), the respondent stated that adequate emergency teams should be available on site at all times.	This is a site-specific issue and is out of scope of GDA. It should be noted, however, that emergency preparedness is one of the key strategic topics for the COMAH Competent Authority. Any future operator would be assessed for the adequacy of their emergency response arrangements.	A7.3 and A7.4
e	In response to question 19, (conclusions) the respondent commented that they think it is a good design.	Consultation response noted.	N/A
ABWR-28 Individual 17			
a	In response to question 5 (management systems), comment was made that the design is fundamentally flawed with a number of long-term issues inadequately addressed.	The respondent does not identify what they consider to be fundamental flaws so we are unable to respond on that point. However, in GDA we assessed the Hitachi-GE management arrangements for the design of the UK ABWR reactor. We noted that Hitachi-GE is certified to ISO-9001 and ISO-14001 and that it has systems in place to ensure the design includes high standards of environmental performance of its reactor. Hitachi-GE has provided good quality technical information to our individual assessors, which has been assessed and our views on the environmental performance are presented in this document. It should be noted that any future operator will require an	A7.3 A7.4 and AR01 (Chapter 5)

Summary of points raised		Our consideration of the points raised	Also noted in:
		environmental permit to operate. Any outstanding information outside the scope of GDA or that is identified as an Assessment Finding will be addressed during the determination process, before the environmental regulator will issue a permit (the Environment Agency in England and Natural Resources Wales in Wales).	
b	In response to question 6 (radioactive waste management), concern was raised that there is no long-term strategy for waste generated by the site, or the hazardous waste which will comprise part of the plant on de commissioning. Comment was made that the financial provision for decommissioning, management and storage/security of high and medium level radioactive waste is entirely inadequate and unsustainable as the half-lives of the elements involved extend far beyond any time for which financial projections can be made. The respondent considers this a fundamental strategic flaw that seriously endangers future generations and the environment of the immediate area and well beyond.	A future operator will be responsible for the management of all waste arisings from the operation and decommissioning of a future UK ABWR. In GDA, we require the requesting party to demonstrate how a nuclear power station will be built, operated and decommissioned in accordance with best available techniques to minimise the generation of wastes and impacts on people and the environment. We note that Hitachi-GE has provided information on predicted waste arisings from the operation and decommissioning of the UK ABWR design. We have assessed this information and provide our findings in our assessment reports on strategic waste management (AR02), best available techniques (AR03) and solid waste and spent fuel (AR06). Hitachi-GE has identified waste management options for all wastes, including longer-lived radioactive wastes such as ILW and spent fuel. Such wastes will be interim stored pending disposal in a future geological disposal facility (GDF). This is consistent with government policy for the management of higher activity radioactive wastes in the UK (NDA, 2015).	A7.3 Also see AR02 (Chapter 6) AR03 (Chapter 8) and AR06 (Chapter 11)
c	In response to question 7 (best available techniques), the respondent states that far too many compromises have been made and that, in most cases, truly safe technology and/or systems are not yet available, (if they ever will be) or would render the project even more uneconomic.	Practicable technology cannot totally preclude radioactive waste arisings and associated discharges. In terms of environmental protection, we are content that the UK ABWR design for GDA will ensure that public dose constraints are met and that BAT is being used to minimise waste arisings and any associated environmental impacts in normal operations. We have worked closely with ONR to support their assessment of whether the design meets appropriate standards in terms of safety and security.	A7.3 and Chapter 7
d	In response to question 9 (gaseous radioactive waste),	Our GDA considers the impact of discharges from normal operation (start-up, operation.	AR04

	Summary of points raised	Our consideration of the points raised	Also noted in:
	concern was raised that estimated discharges do not appear to include discharges as a result of failures or accidents during the lifetime of the project (which every other nuclear project of this type experiences).	shut-down, maintenance and testing and expected events) only. Expected events are any events that can be expected to occur during the lifetime of the plant (such as limited fuel pin failures). Our assessment does not consider the impact of releases to the environment resulting from failures or accidents that are not expected to occur during the lifetime of the plant. ONR is responsible for regulating safety and its assessment of the UK ABWR design includes consideration of accidents and faults.	(Chapter 9) and A7.4
e	In response to question 10 (aqueous radioactive waste), as per above, concern was raised that estimated discharges do not appear to include discharges as a result of failures or accidents during the lifetime of the project (which every other nuclear project of this type experiences).	See response to Point d, above.	A7.4 Also noted in AR05 (Chapter 10)
f	In response to question 13 (impact of radioactive discharges), comment was made that this does not include the impact of probable failures or accidents during the lifetime of the project, its decommissioning and storage of wastes. The respondent requested that a spread of probable scenarios (both short and long-term) should be researched and likely results published.	See response to point d, above.	A7.4
g	In response to question 16 (surface water discharges) the respondent commented that almost every other plant of this type worldwide has caused contamination of groundwater and, in some cases, watercourses due to accidents. The respondent requested that a realistic assessment of how often during the life and decommissioning of the project	See response to point d, above. The Environment Agency and Natural Resources Wales do not normally permit discharges to groundwater and not for nuclear reactors. Our assessment does consider measures in the UK ABWR design to prevent any accidental discharge of pollutants to groundwater and we are satisfied that these are appropriate. This is discussed in our assessment report AR11. Any such discharges would only be the result of accidents and, therefore, come	AR11 and A7.4

Summary of points raised		Our consideration of the points raised	Also noted in:
	this will happen, and the extent of such probable contamination and its duration be prepared and published.	within the remit of ONR who will consider accident risks to groundwater or watercourses.	
ABWR-29 Individual 18			
a	The respondent felt that containment of the nuclear fuel is one of the most important aspects of nuclear reactor design and that fault conditions were critical aspects to consider following equipment failures. The respondent referred to modern design standards for 4 permanent barriers to prevent releases, whereas it was felt that the ABWR only relied upon one less reliable permanent barrier, the nuclear fuel cladding. There was a concern that the ABWR reactor delivers steam directly to the turbine building, which is outside the containment building, therefore any leaking fuel is delivered directly to the environment and mitigation is only provided by a number of onerous actions (for example, detection of fuel leaks and condensing of steam). The respondent felt that the risk of these actions failing had not been reported in the conclusions of the ABWR GDA and therefore it is not known whether the issue has been assessed. Similarly the respondent also felt that it was not known whether the ABWR GDA had assessed the risk of multiple fuel element failure, which could lead to the release of failed fuel into the environment via the steam flow. The respondent was concerned that no overall probability risk assessment has been reported in the results of	Our GDA considers the impact of discharges from normal operation (start-up, operation. shut-down, maintenance and testing and expected events) only. Expected events are any events that can be expected to occur during the lifetime of the plant (such as limited fuel pin failures). The majority of points raised within this comment relate to fault conditions and equipment failures which are a matter for ONR. A copy of this response has, therefore, been provided to ONR for it to consider. We accept that some failures of fuel pins are likely over the lifetime of the plant within normal operations. We have considered the detection of fuel pin failure and discharges as a result of operating with a failed fuel pin under normal operation and consider these acceptable. We are unclear as to which EU report the respondent is referring, or to which standard of BWR this may apply, so we are unable to respond on that matter.	A7.4 see also AR04 (Chapter 9)

Summary of points raised		Our consideration of the points raised	Also noted in:
	the ABWR GDA for comparison with other modern reactor designs. It was suggested that this needs to be done before approval for construction in the UK is given. The respondent felt that, in view of the uncertainty remaining in the assessment of the ABWR design, safety improvements should not be ruled out before consent for construction is given. The respondent recommended that the turbine hall should be redesigned as a nuclear containment building. The respondent referred to an EU review of reactor designs concluding that the PWR was acceptable for construction in the EU, whereas the BWR was not included in this statement of acceptance. Consent for construction of the ABWR in the UK therefore conflicts with the EU's decision. The respondent felt that the preliminary conclusions are profoundly flawed, because they only concern normal operation and do not consider fault conditions after equipment failure.		
ABWR-30 North Wales Fire and Rescue Service			
a	In response to consultation question 16 (surface water discharges), NWFRS noted that consideration has been given in the Hitachi-GE submission to prevent and minimise unintentional discharge to groundwater which includes fire water run-off.	Consultation response noted	N/A
b	In response to consultation question 18 (Control of Major Accident Hazards), NWFRS noted the Environment Agency	Consultation response noted.	N/A

Summary of points raised		Our consideration of the points raised	Also noted in:
	and Natural Resources Wales' opinion with regards to COMAH, and that the GDA is based upon a generic site with only 1 reactor. NWFRS commented that it will make observations should a site-specific application be made in relation to a site situated within NWFRS area as identified in 'National policy statement for nuclear power generation EN-6' ('NPS EN-6').		
c	In response to consultation question 19 (conclusions), NWFRS commented that the content of the GDA consultation is noted and that it deals with the environmental aspects of the design. NWFRS commented that it will make observations in relation to safety and security when consultation is undertaken with the developers ahead of the submission of an application for a Development Consent Order.	Consultation response noted.	A7.4
ABWR-33 The Food Standards Agency (FSA)			
a	In response to consultation question 9 (gaseous radioactive waste), clarification was sought about information in the documents: when quoting the annual limit, the gaseous discharge report (AR04) does not quote any application for the discharge of iodine-131, although iodine-131 is identified in the document as being produced - for example listed on page 21 but not listed in Table 1.	Table 1 of our assessment report for gaseous discharges (AR04) shows proposed annual discharge limits. Many different radionuclides are produced and released to the environment from nuclear power stations. However, only significant radionuclides are specifically named in permits and have limits associated with them. Although iodine-131 will be discharged from the UK ABWR, no limit is specifically associated with this radionuclide as it is not classed as significant for this design due to the very low discharges based on the definition of significance given in our guidance. However, we do think this is a valid comment and we will give this further consideration at site-specific permitting. Significant radionuclides are explained in the assessment report for gaseous discharges (AR04):	AR04 (Chapter 9)

Summary of points raised		Our consideration of the points raised	Also noted in:
		'Hitachi-GE has identified some radionuclides as 'significant' for gaseous discharges to the environment and, therefore, important in any future site-specific permitting. Significant radionuclides are those that are discharged in large quantities, those with the biggest impact on members of the public and the environment, those that are indicators of plant performance or those that are listed in the European Commission recommendations (EC, 2004). The main gaseous discharges, in terms of amount discharged into the environment, are noble gases (argon-41 and isotopes of xenon and krypton), carbon-14 and tritium (H-3). Iodine radionuclides and some radioactive particulates are discharged from the stack in smaller amounts. Hitachi-GE has provided us with proposed annual rolling limits for discharges of gaseous radioactive waste from the UK ABWR (Table 2). Annual limits are proposed for significant radionuclides, and are based on annual discharge estimates for normal operation plus discharges resulting from fuel pin failure.'	
b	In response to consultation question 10 (aqueous radioactive waste), clarification was sought about information in the documents. Comment was made that it is unclear why carbon-14 is not included in the aquatic discharges impact of radioactive discharges.	Carbon-14 is not included in the aquatic discharges due to the method used to derive the source term for discharges. In the methodology, there is an underlying assumption that all carbon-14 is in an oxidised state and partitions to the gaseous waste stream. If carbon-14 were to partition to the liquid waste streams there would be 2 potential outcomes that have not been assessed as part of GDA: • carbon-14 could adsorb onto the waste treatment resins resulting in increased activity in solid wastes • carbon-14 could be released to the environment resulting in a dose contribution not yet assessed We have included an Assessment Finding (AF5) in our BAT assessment report (AR03) to ensure future operators verify this assumption.	AR05 (Chapter 10)

Summary of points raised		Our consideration of the points raised	Also noted in:
		Assessment Finding 5: A future operator shall assess the partitioning of carbon-14 between gaseous, aqueous and solid waste streams, during initial operations.	
c	In response to consultation question 13 (impact of radioactive waste) comment is made that the consumption data used in the GDA does not reflect the current national published data. The FSA commented that it would consider using the following data on consumption for generic assessments: National Diet and Nutrition Survey: results from Years 1 to 4 (combined) of the rolling programme for 2008 and 2009 to 2011 and 2012. The FSA identified that this is available online at the following location: https://www.gov.uk/government/statistics/national-diet-and-nutrition-survey-results-from-years-1-to-4-combined-of-the-rolling-programme-for-2008-and-2009-to-2011-and-2012 Bates B, Cox L, Nicholson S, Page P, Prentice A, Steer T, Swan G (2016). National Diet and Nutrition Survey Results from Years 5 and 6 (combined) of the Rolling Programme (2012/2013 – 2013/2014). FSA identified that this is available online at the following location: https://www.gov.uk/government/statistics/ndns-results-from-years-5-and-6-combined	For GDA, the assessment uses a generic site. The generic site reflects the environmental aspects of the sites at which a power station might be built. A generic site is defined in terms of generic non-site-specific data. The assessment of the impacts at the generic site makes use of the relevant parts of the dose principles document. Our assessment used published Public Health England habits data. Our approach was consistent with guidance presented by the National Dose Assessment Working Group (NDAWG). In summary the NDAWG guidance suggests that the so called top 2 approach can be used for generic assessments. The top 2 approach requires information on the 95th or 97.5th percentile consumption rates, which are not presented in these national diet surveys (NDS). If an application for a permit to operate a nuclear power station is received, a site-specific assessment of the impact will be required. All nuclear sites have site-specific habit data published which will be used for permitting. For the site-specific assessment, we expect Horizon Nuclear Power to follow NDAWG guidance. Environment Agency and Natural Resources Wales will make their own assessment and will also use NDAWG guidance and local habits data where available.	AR09 (Chapter 13)
d	The FSA commented that, in considering the distance from the site of the representative groups, the assessment has used a range of distances and that the choice of these locations is unclear. The FSA further commented that the assessment of the food pathway considered that food	In respect to food locations, the baseline assessment is for a generic site, where food production locations are not known. There is a balance between the food production locations, availability of suitable land and suitable area of land, maximum ground level air concentrations, and release heights. The dose principles document, of which the Food Standards Agency is joint author, has been followed. The dose principles	AR09 (Chapter 13)

Summary of points raised		Our consideration of the points raised	Also noted in:
	production is at 500 m, when a more pessimistic assumption and in some cases more realistic assumption is 100 m, for example there is food production within 100 m of one of the proposed sites, Wylfa.	document recommends consideration of sufficient land to allow sufficient food production that can be sustained an assessment at the point of maximum deposition. The dose principles document does not recommend an assessment at the point of maximum air concentration and ground deposition. The point of maximum air concentration and ground deposition may be fairly localised and cover a small area. It is unlikely that the point of maximum air concentration and deposition will meet the approach suggested in the dose principles document. For a generic site assessment and for screening assessments the location of food production is normally assumed to average around 500 m from the release point. The release point itself could be several hundred metres inside the site boundary. Therefore, any locations at which food could be produced could be close to the site boundary and also spread some distance from the boundary and release point. A significant amount of land is required to sustain a reasonable amount of food production. Therefore, 500 m is a reasonable average distance to represent food production - between 300 m and 700 m from the release point. The actual food production locations are site-specific and will be identified and assessed on an appropriate basis during our assessment for a permit application at a specific site.	
e	The FSA stated that it is unclear whether the assessment has considered the maximum deposition and air concentration locations to work out the activity concentration in food and other pathways. FSA recommended that for a generic assessment the maximum deposition and air concentration outside the expected site perimeter would provide the most conservative approach. Further comment was made that this could be as close in as 100 m that was suggested in the IRAT	Our reply to Point 5, above, explains the overall approach taken to food production assessment and explains why using the point of maximum air concentration and deposition is unlikely to be appropriate for the assessment at GDA.	AR09 (Chapter 13)

Summary of points raised		Our consideration of the points raised	Also noted in:
	assessment tool (initial radiological assessment tool) or further out.		
f	The FSA commented that when considering the modelling of the gaseous discharges, the document is unclear on the reasons for the assumptions used and the weather patterns for the generic site.	Assumptions that affect gaseous discharge include stack height and weather patterns. Stack height was selected to be representative of the UK ABWR stack protrusion above the reactor building, taking into account the effect of the wake of the building and we consider the selected height appropriate (see Chapter 13). On weather patterns, the meteorological data assumptions are described in assessment report AR08. In modelling gaseous discharge, Hitachi-GE uses a recognised system of categorising the stability of atmospheric conditions. The range of categories used (for different stable and unstable conditions and the proportions of each) are representative of coastal conditions and we consider this appropriate for a generic site at GDA. For site-specific permitting, it is expected that site representative meteorological data will be used.	AR08, 09 (Chapter 13)
g	The FSA queried whether there is a national representative windrose for the 'annual wind information' to do a generic design assessment.	In respect to atmospheric dispersion for the UK, this divides the UK atmosphere into 8 stability categories, with different boundary layers and wind speeds. Some categories have a greater dispersive effect and lead to lower air concentrations at ground level. Each category has a frequency of occurrence, which varies around the UK. The assessment made by Hitachi-GE uses data for a generic site that is based on Wylfa, and, therefore, uses data from weather patterns likely to be experienced near Wylfa. However, a generic site by definition does not have a specific windrose, so therefore a uniform windrose is likely to be appropriate. The independent assessment made by the Environment Agency uses weather patterns based on a generic site similar to Oldbury and a uniform windrose. We would expect site-specific data including site windrose data to be used in any assessment for a permit application for a specific site.	AR09 (Chapter 13)
ABWR-35 Public Health England (PHE)			

Summary of points raised		Our consideration of the points raised	Also noted in:
a	In response to consultation question 9 (gaseous radioactive waste), PHE commented that: • (i) PHE notes that estimated annual gaseous discharges of carbon-14 and tritium from the UK ABWR are higher than the mean annual discharges from other operating BWRs, but still sit within the range of data values obtained for operating BWRs across the world. PHE notes the explanation for the tritium discharges given in paragraph 252 and the request by the Environment Agency for further information related to carbon-14 in paragraph 260. PHE is confident that the Environment Agency will follow up and review these matters and will make the information publicly available. • (ii) The units in the first table of Section 9 are incorrect. The annual limits should be given as Bq rather than GBq. • (iii) Para 253: the upper limit of the range of discharges is 1.6E+01 GBq/GWeh as in Table 9.4. • (iv) Para 257: the lower limit of the range of particulate discharges should be 1.3E-13 GBq/GWeh as in Table 9.6. • (v) Consultation document, paragraph 259: the lower limit of carbon-14 discharges should be 4.1E-03 GBq/GWeh as in Table 9.7.	a(i). Our consultation document states: 'Estimated annual discharges of gaseous carbon-14 from the UK ABWR are higher than the mean annual discharges of gaseous carbon-14 from other operating BWRs but sit within the range of data obtained for operating BWRs. We are requesting further information on this matter and will consider the response when it has been submitted and report on it in our final decision document.' We did not have the information on the reasons for estimated carbon-14 discharges being higher from the UK ABWR than mean carbon-14 discharges from other BWRs and ABWRs. We have now received this information. Hitachi-GE has confirmed that this is due to conservatisms in its methodology used to derive estimated carbon-14 discharges. This has been updated in this decision document (see Chapter 9). a(ii), a(iii), a(iv) and a(v). Errors are noted and have been corrected.	AR04 (Chapter 9)

Summary of points raised		Our consideration of the points raised	Also noted in:
b	In response to consultation question 10 (aqueous radioactive waste) PHE commented that: • (i) PHE agrees with the preliminary conclusions • (ii) Table 8 of the Assessment report AR05 gives a value of .7.6e+11 - should be corrected to 7.6e+11 • (iii) Consultation document, Table 10.1: the mean of liquid tritium discharges in 2006 should be 9.9E 02 GBq/GWeh and in 2010 should be 9.7E 02 GBq/GWeh. The minimum in 2005 should be 2.6E 04 GBq/GWeh and in 2007 should be 5.3E 04 GBq/GWeh; the minimum in 2012 carries an extra significant figure. These figures are given in the report 'Discharges from boiling water reactors'	b(i). Consultation response noted. b(ii) and b(iii). Errors noted and have been amended in the updated AR05 assessment report (Environment Agency, 2017e) and this decision document.	AR05 (Chapter 10)
c	In response to consultation question 13 (impact of radioactive discharges), PHE commented that: • (i) PHE believes that the general approach and the methodology adopted by the Environment Agency in assessing the radiological impact of radioactive discharges are reasonable. PHE is therefore confident that the results of this assessment are sound and robust; PHE agrees with the preliminary conclusions reached by the Environment Agency. • (ii) A review has been carried out of Chapter 13 of the Environment Agency: GDA consultation document	c(i), c(ii) and c(iii). Consultation response noted. c(iv). The input data (meteorological data, habits and assumptions about food production) are found in the detailed technical appendices – that is Appendix B, C and D of Hitachi-GE's submission (Hitachi-GE, 2017e). The independent dose assessment undertaken by the Environment Agency gives input data including meteorological data, habits data and land use data in the appendices to the independent dose assessment Appendices C, D, E, F, G and H (Environment Agency, 2016c). We have not made any specific comments on the suitability of the input data in the consultation. We have realised that there are several inconsistencies between the results given in our assessment report 09 (AR09) and the	AR09 (Chapter 13)

Summary of points raised	Our consideration of the points raised	Also noted in:
for the UK ABWR. In addition, the supporting documents AR09 – Assessment of radiological impacts on members of the public and AR10 - Assessment of radiological impacts on non-human species have been considered. • (iii) Chapter 13 of the Environment Agency: GDA consultation document for the UK ABWR is clearly laid out with the aims of the assessment identified and the generic site concept explained. Radiological impact assessments have been carried out to verify and validate the dose calculations submitted by Hitachi-GE and in addition independent assessments have been performed for comparison. Individual and collective doses have been calculated to humans and dose rates calculated for non-human biota. The results of the various assessments are in general agreement and lead to the conclusion that the impact of gaseous and liquid discharges at the proposed discharge limits will not give rise to doses that exceed the dose constraint or limit for humans or the dose rate criterion for non-human biota. • (iv) Full details of the input data used in the dose assessment calculations are not provided in these 3 reports. For example, meteorological data, assumptions about food production areas and a full description of habit data for	consultation document itself. These were induced by changes made by Hitachi-GE to the source term in July 2016 in draft F. In the July update, increases in discharges of some radionuclides were made. The increased discharges lead to increases in doses by up to 4 μSv/y. The assessment report AR09 was updated with the revised discharges and doses. However, not all the revised doses were transferred into the summary tables of the consultation document itself. Therefore, there are some inconsistencies. However, the differences between AR-09 and the consultation document are very small and do not alter the provisional conclusions. c(v), c(vi), c(vii), c(viii), c(ix) and c(x). This decision document has been amended accordingly. c(xi). We have amended this decision document to include a footnote for + (relating to noble gases). c(xii). A footnote has been added to identify age group in this decision document. c(xiii). Doses to foetus were not calculated in stage 3. This is because doses to the foetus are higher than other age groups for a small number of radionuclides. The nuclides that affect the foetus more are not in the discharges from the UK ABWR. c(xiv). This decision document has been amended accordingly. c(xv), c(xvi) and c(xvii). The physical height assumed was 57 m (based on Hitachi-GE information). The effective height for a 57 m stack is 19 m and the assessment was based on the 19 m height, whilst in stage 2 the nearest height of 20 m was used. Hitachi-GE has used an effective height of 19 m for its assessment of doses to non-human organisms. Therefore, the assessments are consistent. c(xviii). The approaches adopted to the assessment that Hitachi-GE provided (Hitachi-GE, 2017e) and our independent assessment (Environment Agency, 2016c) are somewhat different. The outcomes are different in terms of predicted dose, but both	

Summary of points raised	Our consideration of the points raised	Also noted in:
the local population are not available. It has therefore not been possible to comment on the suitability of assumptions and data that have gone into the dose assessments. It is also not clear, from Chapter 13 alone, whether the doses calculated are to a particular age group or an amalgamation of doses to different age groups. There appear to be some inconsistencies between Chapter 3 and AR09. • (v) Table 13.1 in Chapter 13 in the table header should dosea should be dose(a)? • (vi) Table 13.1 in Chapter 13 gives stage 1 Hitachi-GE dose as 143 µSv/y – if this includes direct radiation I think it should be 144 as in AR09. • (vii) Table 13.1 in Chapter 13 - Table footer could clarify that "Doses to those most exposed to aqueous liquid discharges were very low in the range 0.000005-0.0002 µSv/y" • (viii) Table 13.2 in Chapter 13 - Total dose from stage 1 given as 139 µSv/y which does not seem to be consistent with Table 13.1 or Table 6 in AR09 • (ix) Table 13.2 in Chapter 13 - Doses from stage 2 do not seem to be consistent with Table 6 of AR09 • (x) Table 13.2 in Chapter 13 - Doses from aqueous discharges for stage 3 do not seem to be consistent with Table 7b of AR09 • (xi) Table 13.2 in Chapter 13 - Is the dose from a short	assessments show very low doses, due to the low levels of short duration discharges of noble gases. As part of any application for a permit for a new nuclear power station, a site-specific assessment will be made as required by the permit application process, which will include a reassessment of short duration releases to atmosphere c(xix). The probability that the screening dose rate will be exceeded is calculated within the ERICA tool as part of the ERICA assessment. A tier 3 assessment is not necessary for this; this probability is calculated for tier 1 and tier 2 assessments. For tier 2 assessments, this probability is provided within the ERICA results tables as a risk quotient, and is dependent on the screening dose rate selected, the calculated dose rates and the uncertainty factor selected for the assessment. The assessment report covering non-human radiological assessment states: 'The results produced from the ERICA tool includes a risk quotient, which provides a probability that the selected dose rate criteria may be exceeded'. More information about how the ERICA tool works can be found in the ERICA tool help function.	

Summary of points raised		Our consideration of the points raised	Also noted in:
	duration release due entirely to cloud beta and cloud gamma exposures because source term is only noble gases? There is no note of what the + under the short duration release refers to. • (xii) Table 13.3 - It is noted that these doses are to the representative person and yet the doses given for stage 3 are for different age groups (see Table 9 of AR09) • (xiii) Para 418 - doses to fetus are calculated but are not mentioned in note (c) of Table 13.1. • (xiv) Para 428 refers to the Health Protection Agency but should now refer to Public Health England • (xv) Para 444 - A stack height of 57 m is assumed for non-human biota and yet for humans a stack height of 20 m. • (xvi) If human and non-human assessments are to be integrated they need to be consistent. • (xvii) Para 445 - What was the realistic stack height used 57 m or 20 m. • (xviii) Para 458 - Are the results from the independent assessment of short duration releases (Table 9c of AR09) consistent with the Hitachi-GE assessment? • (xix) Para 461 - It is not clear how probability that screening dose will be exceeded is calculated. Can this be done without using ERICA Tier 3?		
d	In response to consultation question 14 (radioactive substances permitting), PHE	Consultation response noted.	N/A

Summary of points raised		Our consideration of the points raised	Also noted in:
	commented that it agrees with the preliminary conclusions.		
e	In response to consultation question 15 (water abstraction), PHE noted that potential public health implications relating to water abstraction were not considered in the submitted report.	The GDA process requires the requesting party to identify the fresh water and cooling water requirements for the design and determine whether any permit or consent for water abstraction is required. Should a future operator require a permit for water abstraction it is at this permit application stage that any health implications would be considered.	A7.3
f	In response to question 16 (surface water discharges), PHE referred to Section 4.2 of the Assessment report AR11 (12th December 2016), which considers discharges to surface water. PHE noted that discharges to waters will be controlled by an environmental permit and the Environment Agency's conclusions contained in paragraph 4.4 of the Assessment report AR11 (12th December 2016). • the UK ABWR will have non-radioactive discharges to surface water and will require an environmental permit for a water discharge activity • the UK ABWR is likely to be acceptable for granting an environmental permit for discharges to surface water PHE commented that any future operator will need to provide more detailed information on the volumes and composition of the various aqueous waste streams and demonstrate that the environmental impact from the discharges is acceptable.	We agree and this is consistent with our conclusions on water discharges in AR11, and in particular Assessment Finding 16.	AR11 (Chapter 16)
g	Further in response to question 16 (water discharges), PHE also commented that having reviewed the submitted documentation PHE notes that	Consultation response noted. Should a future operator require a permit for water discharges, Public Health England and Public Health Wales would be consulted at	N/A

	Summary of points raised	Our consideration of the points raised	Also noted in:
	there are number of uncertainties in the chemical composition of the various waste water streams. However, in light of the Environment Agency's conclusions PHE is satisfied that the GDA has not identified any significant risk to public health associated with the handling or disposal of waste water to surface waters. PHE would however request the ability to comment further at such time that an application for the environmental permit is made.	the permit application stage and any health implications would be considered.	
h	Further in response to question 16 (surface water discharges), PHE also commented in terms of groundwater discharges that they note that there are no plans for any routine discharges to ground water and that an environmental permit is unlikely to be required. PHE noted that Hitachi-GE is proposing to implement best available techniques for the control of accidental spills and releases but that the details of these schemes can only be provided as part of a site-specific application. PHE noted the Environment Agency conclusions in paragraph 4.4 of assessment report AR11 and on this basis have not identified any significant risks to public health as a result of discharges to ground water.	Consultation response noted.	N/A
i	In response to consultation question 17 (installations), PHE noted that the GDA states that combustion plant will be present (in the form of emergency generators, fire protection pumps and diesel fired boilers). PHE further noted that the UK ABWR	Consultation response noted.	N/A

Summary of points raised		Our consideration of the points raised	Also noted in:
	combustion plant will be a Part A(1) installation and require an environmental permit from the Environment Agency. PHE also noted the Environment Agency's conclusion (paragraph 6.4 of assessment report AR11) that in principle a permit should be able to be issued. PHE stated that, as the emissions from these installations will be controlled by the conditions of the aforementioned permit, PHE does not wish to make any further comment at this time.		
j	In response to consultation question 18 (Control of Major Accident Hazards), PHE notes the conclusions re: the COMAH statistics of the site contained in paragraph 7.4 of the Environment Agency Assessment report - AR11 Other Environmental Regulations (12 December 2016) and accepts the conclusions reached by the Environment Agency and has no further comments to make at this time.	Consultation response noted.	N/A
k	In response to consultation question 19 (conclusions), PHE commented that it agrees with the Environment Agency preliminary conclusion that it could issue an interim statement of design acceptability for a generic site subject to no outstanding GDA issues. PHE noted that detailed site-specific assessments of the potential impacts of discharges to the environment will be required at the permit application stage. PHE highlighted that it is a consultee to bespoke environmental permit applications and will provide further comment	Consultation response noted.	N/A

Summary of points raised		Our consideration of the points raised	Also noted in:
	regarding all aspects of the impact of these discharges to environment on a case-by-case basis.		

Appendix 7.3 Responses that fall outside of the scope of our GDA remit

A number of points within responses from individuals and organisations raised matters outside the scope of GDA or our regulatory remit. These comments are summarised in this appendix, with a short note as to why we are not considering them in our GDA. Those relevant to other parties have been referred to the relevant organisation and these are identified in section A7.4.

Matters associated with planning

Some respondents (ABWR-01, ABWR-02, ABWR-07, ABWR-11 and ABWR-12) raised concerns about impacts such as visual, air quality, noise, odour, vibrations and disruption from both construction and any completed power station. They asked if environmental impact assessment was linked to GDA assessment. Respondents also asked if reactor designers were considering wider environmental impacts than just waste.

Our response

GDA assesses a generic reactor design and is not site-specific. Site-specific issues such as visual, air quality, noise, odour, vibrations and disruption are out of scope of GDA and will be assessed by the relevant organisations as part of any site-specific application, including planning application and relevant permit applications and site licensing, in the context of the local surroundings. Site-specific matters out of the scope of our GDA are discussed further below.

Environmental impact assessments are carried out by developers in support of applications for planning consent. The impacts assessed relate to the specific development that is proposed and would be wider than those considered in GDA. In making their site-specific environmental impact assessments, developers can/should draw on the information that has been presented in GDA where it is relevant to their proposals. The Environment Agency or Natural Resources Wales have a role as a statutory consultee on relevant planning matters.

As part of GDA we have sought and received information from the reactor designers on a number of environmental areas, for example combustion plant such as standby generators, as well as waste.

Concerns about creation of waste and spent fuel

Some respondents (ABWR-02, ABWR-04, ABWR-13, ABWR-15, ABWR-25, ABWR-28, ABWR-32) were concerned about the proposed waste management strategy and proposals for new build wastes and spent fuel. These concerns were because of their reliance on the development of a geological disposal facility (GDF) and need for interim storage of wastes until the facility became available.

Some (ABWR-02, ABWR-13, ABWR-15) considered that interim stores could actually become permanent disposal sites or be required for protracted periods.

Some (ABWR-02, ABWR-13, ABWR-15) were concerned about impacts on their local communities of long-term interim waste and spent fuel storage and some that local communities were not well informed about the proposals.

Some (ABWR-07, ABWR-13, ABWR-28, ABWR-32) considered proposals were uncertain or unsatisfactory, or that a credible case for nuclear waste disposal has yet to be developed, or that there were issues with current proposals. Some took the view that no new build construction should begin or radioactive waste or spent fuel be created until adequate radioactive waste disposal facilities had been made available.

Some respondents (ABWR-02, ABWR-15, ABWR-25) were concerned about the timescales for a GDF.

Our response

Many of these points relate to UK energy policy which includes use of nuclear power. A consequence of nuclear generation would be the creation of radioactive waste and spent fuel. Responsibility for setting energy policy is for government and the role of nuclear power generation is set out in a White Paper together with relevant Energy National Policy Statements including the Nuclear National Policy Statement. We provide advice to government to help ensure that there is a robust approach to the treatment of uncertainties and risks in national policies and strategies. Energy policy and the National Policy Statements were published following extensive consultation. Energy policy is outside regulators' responsibility and the scope of our GDA consultation.

The need for a GDF to be developed for disposal of radioactive wastes is well established and will be required whether or not new nuclear power stations are built. Government's policy for securing this facility is set out in the Implementing Geological Disposal White Paper (DECC, 2014a). The Department of Business, Energy and Industrial Strategy is responsible for government policy on radioactive wastes and it has given the responsibility for implementation of a GDF to Radioactive Waste Management (RWM), a wholly owned subsidiary of the Nuclear Decommissioning Authority (NDA).

The need for confidence in arrangements for the management and disposal of the radioactive wastes and spent fuel that would be created by new nuclear reactors was recognised in the 2008 Nuclear White Paper. Government states in the Nuclear National Policy Statement that "In reaching its view on the management and disposal of waste from new nuclear power stations the Government has in particular satisfied itself that:

a) geological disposal of higher activity radioactive waste, including waste from new nuclear power stations, is technically achievable;

b) a suitable site can be identified for the geological disposal of higher activity radioactive waste; and

c) safe, secure and environmentally acceptable interim storage arrangements will be available until a geological disposal facility can accept the waste".

The purpose of the Nuclear National Policy Statement was to provide guidance to the Infrastructure Planning Commission (IPC) about its planning decisions. The Planning Inspectorate has now replaced the IPC and makes recommendations to the relevant Secretary of State for their decision. The Environmental Permitting Regulations ensure that the Environment Agency and Natural Resources Wales will be involved in assessing the proposed GDF from an early stage in its development. We will also, as for GDA, scrutinise and assess the disposability assessments that operators request from RWM to satisfy ourselves that the wastes, and spent fuel, should be capable of being disposed of in the GDF once available.

Site-specific concerns

Some respondents (ABWR-02, ABWR-05, ABWR-06, ABWR-07, ABWR-12) were concerned about or queried the fact that GDA had considered direct cooling associated with the design, whereas an estuarine site such as at Oldbury may require cooling towers due to lesser availability of cooling water flows. Some expressed concern that cooling towers had not been addressed, some that GDA was "too generic" and some that cooling towers would present other risks and issues. Some expressed a concern as to whether the assessed design would be effective and suitable for both cooling methods.

Some (ABWR-09) raised concerns about intermediate level waste and spent fuel containers and if they were approved for transport to and disposal in the planned UK GDF. The respondent commented that there is a need to ensure compatibility prior to operations to avoid the need for repackaging.

Some (ABWR-01, ABWR-08, ABWR-10, ABWR-11, ABWR-12, ABWR-34) were concerned that flood defences, flooding and climate change had not been adequately considered as part of the GDA design and some commented specifically that Oldbury would not be a suitable site for this reason.

Some (ABWR-02) noted that the location and height of the gaseous discharge stack must be considered on a site-specific basis to minimise impacts to members of the public and the environment.

Some (ABWR-02, ABWR-09) commented that the design must be suitable for adaption to specific sites or queried whether the design would automatically be considered suitable for an estuarine site.

Some (ABWR-09, ABWR-33) considered that dose assessments would need re-working on a site-specific basis or that further information would be required to enable replication at the site-specific assessment stage.

A respondent (ABWR-14) requested that estimated doses were prepared specifically for the population of Wales.

A respondent (ABWR-33) commented that documents did not include consideration of doses to houseboat dwellers, noting that one possible site (Oldbury) had a known significant dose to houseboat dwellers based upon habit survey data, as did other UK sites.

A respondent (ABWR-35) noted that potential public health implications relating to water abstraction were not considered in the submitted report.

Some (ABWR-05, ABWR-09) considered that aqueous discharges would require re-assessment at the site-specific stage for an Oldbury site due to the lower water flow in the receiving environment.

Some (ABWR-15) referred to the thermal outputs of the Wylfa Newydd emergency diesel generator proposals, effect on local air quality and the need for design changes to be fed to regulators early.

Some (ABWR-03) considered that high concentrations of organic material in the marine environment around the Wylfa may influence tritium behaviour and impacts.

Some (ABWR-02) stated that further evidence is required on how decommissioning would be facilitated and how impacts on local people and the environment would be minimised.

One respondent (ABWR-12) was concerned about the vulnerability of nuclear power to terrorist attack, natural phenomena and cost cutting governments. Concerns were also raised about a potential Oldbury site due to the fragility of the local environment and its proximity to centres of population.

Some (ABWR-09) queried whether the site would become a lower tier COMAH establishment due to the quantities of diesel stored and whether this would only apply once a second reactor was built.

Our response

Many of these points relate primarily to site-specific matters that are not assessed at the GDA stage, but during environmental permitting and site licensing once proposals for a specific site have been brought forward.

The GDA process allows the regulators (the Environment Agency, Natural Resources Wales and ONR) to assess the safety, security and environmental impacts of new reactor designs at a generic level, before receiving an application to build a particular nuclear power station design at a specific location, therefore identifying potential issues and offering recommendations on the UK design at an early stage.

The SoDA or iSoDA is provided as advice to the requesting party, under Section 37 of the Environment Act 1995 and the Natural Resources Body for Wales (Establishment) Order 2012. It has no other formal legal status. It confirms we consider a power station based on the design could be built and operated in England and Wales. However, before that could happen the site operator would need to apply for and obtain site-specific environmental permits (and other permissions). A

SoDA does not guarantee that a site-specific proposal based on the design will receive environmental permits in the future.

At the end of the GDA phase we also identify Assessment Findings that identify matters prospective operators must address at the site-specific phase. In the site-specific permitting phase, we receive applications for environmental permits for specific sites. In determining these applications, we take full account of the work we have done during GDA, so that our efforts are focused on operator-specific and site-specific matters, including how the operator has addressed any relevant matters arising from GDA. Any proposed changes to the design or site choices beyond the generic site envelope affecting the environmental aspects would need to be reassessed (for example, changes in approach to cooling or discharge arrangements), as would more detailed and new design information available at that stage.

The site-specific permitting phase includes more locally-focused consultation, allowing further opportunity to comment upon site-specific issues such as those raised here.

We believe that, overall, this 2-phase approach provides a streamlined process for site-specific applications, while ensuring robust and transparent scrutiny of proposals and properly protecting people and the environment.

Some examples of issues that would be evaluated in detail at the site-specific stage are disposability of waste packages, flood defence structures, environmental implications of a cooling tower and site-specific dose pathways (for example, people living locally on houseboats).

With regards to COMAH requirements and designation of a particular site as a COMAH establishment, this will, similar to permits, be considered at the site-specific stage.

Funding and cost matters

Some respondents (ABWR-04, ABWR-10, ABWR-11, ABWR-23) considered that new nuclear power was too expensive.

Some respondents (ABWR-04, ABWR-10, ABWR-12, ABWR-20, ABWR-28) considered that large government subsidies would be required to make new nuclear power viable and that it committed us and future generations to large costs. Some (ABWR-20, ABWR-23) commented that it was untrue that electricity from nuclear would be “too cheap to meter”.

A respondent (ABWR-21) questioned the cost benefits of allowing different operating companies, as joint cost saving opportunities are eliminated.

A respondent (ABWR-10) considered that already high costs did not take account of the real costs and dangers of the extraction, transport and disposal of radioactive materials.

Our response

These are matters for government and outside our regulatory remit and the scope of GDA. Government policy on new nuclear power stations and the role of the private sector and regulators is set out in the 2008 White Paper on Nuclear Power, Meeting the Energy Challenge, (BERR, 2008).

Comments about alternative energy sources and energy saving

Some respondents (ABWR-01, ABWR-10, ABWR-17, ABWR-23, ABWR-34) considered that rather than nuclear power, other renewable energy sources should be supported. Some considered that recent advances in renewable technologies, energy storage technology and energy saving measures should provide for sufficient energy needs without nuclear power. Some considered that nuclear power was a redundant technology.

Our response

The government has asked the regulators (the Environment Agency, Natural Resources Wales and ONR) to consider 'pre-authorisation assessments' of new nuclear power stations. In response, the regulators developed GDA, which allows us to assess the safety, security and environmental impacts of new reactor designs at a generic level, before receiving an application to build a particular nuclear power station design at a specific location. Consideration of energy sources other than nuclear power is beyond the scope of GDA and a matter of government policy.

Concerns about design safety and acceptability

Some respondents (ABWR-01, ABWR-04, ABWR-07, ABWR-10, ABWR-11, ABWR-12, ABWR-13, ABWR-17, ABWR-20, ABWR-23, ABWR-24, ABWR-28, ABWR-34) were concerned about the safety of nuclear power and considered that new nuclear power stations should not be allowed to be constructed. In raising these concerns, some respondents considered the technology dangerous, dirty and outdated, some referred to unacceptable levels of contamination that may result, some considered designs unacceptable and some considered that they could not be justified when taking into account safety and commercial issues. One respondent (ABWR-23) considered that learning had not been taken from other worldwide nuclear disasters and did not take full account of waste that would be generated. Some (ABWR-20) considered that nuclear power was not compatible with life on this planet.

Some (ABWR-02) emphasised that high standard of protection for people and the environment should be ensured.

Our response

These points relate primarily to matters of government policy and are, therefore, outside the scope of GDA.

Through our regulation, we ensure that all nuclear power stations will be acceptable with regards to protecting people and the environment, for matters within our remit. We would not issue a SoDA or iSoDA if we were not satisfied that a generic design could be safely built to ensure the protection of people and the environment. Once site-specific applications are received, we would not grant permits unless we were satisfied that operation of the site would ensure protection of people and the environment, taking into account the local context. Within our assessments, we require requesting parties and prospective operators to take into account national and international learning and waste generation.

A number of the points raised also fall outside our regulatory remit and have, therefore, been passed to others to consider, primarily ONR, as detailed further in Section A7.4.

Other comments with our responses

One respondent (ABWR-12) considered that a new nuclear power station and, in particular a boiling water design, should not be built at Oldbury as it is untested. The ABWR has been built and operated in Japan. We would not issue a SoDA or iSoDA if we were not satisfied that a generic design could be safely built to ensure the protection of people and the environment. Once site-specific applications are received, we would not grant permits unless we were satisfied that the operation of the site would ensure protection of people and the environment, taking into account the local context. Similarly, ONR would not consent to a license without being satisfied that acceptable safety and security measures were in place.

A respondent (ABWR-28) considered the design to be fundamentally flawed, with a number of long-term issues inadequately addressed. However, there was no further information on what issues were inadequately addressed and so this comment cannot be addressed further other than to confirm that we would not issue a SoDA or iSoDA if we were not satisfied that a generic design could be safely built to ensure the protection of people and the environment.

In response to questions about monitoring of discharges and disposals, a respondent (ABWR-28) commented that “measuring a cancer does not cure it”. We take this as a concern about potential health impacts. These are addressed by Public Health England.

Some (ABWR-20) queried the legality of acceptable levels of radioactive discharges emitted from nuclear reactors. We set limits on the permitted levels of discharge, and discharges within these limits and within the scope of the permit can be made legally. It is our job to grant permits that set limits that are acceptable and to subsequently regulate nuclear operators to ensure compliance with these permits. One respondent (ABWR-03) asked that comment be made on whether or not lifetime extensions will be prohibited for any future operating UK ABWR. This matter is primarily within the remit of the ONR. Lifetime extensions are not currently prohibited, but instead will be considered, if an application is made, as part of normal regulatory business by both ONR and the Environment Agency / Natural Resources Wales at that time. We note that permits are not time limited and operators are required to ensure ongoing safe, secure, environmentally acceptable operation.

Some (ABWR-09) queried whether there would be any impact on radiocarbon dating technology used in the vicinity of a power station as a result of discharges of carbon-14. This matter is outside of our regulatory remit and was, therefore, not considered as part of our GDA assessment.

One respondent (ABWR-04) raised concern that the project is a threat to the survival of the Welsh language and culture on Anglesey. This is a matter that will be taken into account at the site-specific determination stage and Natural Resources Wales will consider it line with its obligations under the Well-being of Future Generations Act 2015.

A respondent (ABWR-18) simply stated “Discharge limits”. We are unable to answer this comment other than to confirm that any environmental permit would contain appropriate discharge limits for both aqueous and gaseous discharges.

Some comments we received (ABWR-27, ABWR-31) were duplicates of others. In these cases, we have only responded to the first set of comments, therefore these comments are addressed under ABWR-16 and ABWR-12 respectively.

One comment (ABWR-26) was blank and cannot be responded to.

Appendix 7.4 Responses outside of our regulatory responsibilities

Where the points raised by individuals and organisation lie outside our regulatory responsibilities, we have passed a copy of the consultation response to the appropriate organisation for them to consider the points made. Please note that, the environment agencies, in line with normal regulatory process, have chosen to consult and respond to public comments in this matter. Other organisations involved have also chosen to follow their normal public interaction processes, which may not include consultation. Responses received that are relevant to organisations other than the Environment Agency and Natural Resources Wales have had all personal data removed before being passed on, due to data protection requirements. Therefore, the receiving organisations will not be able to reply to individual responses.

Below, we briefly summarise comments that fall into this category and indicate to which organisation we have passed copies of the consultation response.

In some cases, consultation responses are partially within our responsibility and partially within that of other organisations. In these cases, we have also responded elsewhere within this document.

Many of the points addressed in this section relate to accidents and failures. The scope of our considerations within GDA is normal operations only, which includes start-up, operations, shut-down, maintenance/testing and foreseeable events such as limited fuel failures. It does not cover accidents or unforeseeable events, which are a matter for ONR. A range of other points also come wholly or partially within the remit of ONR such as flood risks, evacuation plans and emergency arrangements, reactor lifetime extensions, waste storage, quality control of reactor construction and worker radiation exposure rates.

A number of points fall within the remit of Hitachi-GE, Horizon Nuclear Power, Public Health England or the Welsh government as summarised below.

Table A7.3 Points raised by individuals and organisations that fall outside or partially outside our regulatory responsibilities and have been passed on to other organisations for consideration

Response reference	Summary of point raised outside our responsibilities[7]	Responsible organisations provided with a copy	Also addressed in section
ABWR-01	Impacts of flood risk on safety.	ONR	A7.3
	Lack of evacuation plans in the area in the event of an incident.	ONR	
ABWR-03	Events and criticality risks associated with the spent fuel cooling ponds.	ONR	A7.2
	Accidental discharges from BWRs / ABWRs.	ONR	
	Quantification of the risk of accidental discharges.	ONR	

[7] Where points do fall partially within our responsibility the comment is also addressed elsewhere in this document

	Quantification of the risk of accidental discharges in relation to plant lifetime extensions.	ONR	
	Prohibition of plant lifetime extensions.	ONR	A7.2
	Washout/fallout resulting from accident scenarios.	ONR	A7.2
ABWR-04	Amount of high level waste expected to be stored on site with 2 ABWR reactors.	ONR	A7.2
	Natural Resources Wales is only consulting on normal operations and not consulting on abnormal behaviours or accidents.	ONR	A7.2, A7.3
	Large reactors with waste store create a risk of nuclear accident.	ONR	A7.2, A7.3
ABWR-05	Wider safety aspects should also be given transparent consideration and ideally consulted upon.	ONR	
	Fuel reliability and implications for turbine and condenser contamination, particularly with tritium.	ONR	A7.2
	Quality control of the build.	ONR	
ABWR-08	Flood defence.	ONR	A7.3
ABWR-09	Query about a Hitachi-GE lessons learned register and whether Hitachi-GE will offer formal technical services to operators.	Hitachi-GE	A7.2
	Regulation of waste on site and transfer of spent fuel and high activity waste to a GDF.	ONR	
	Likelihood of multiple fuel pin failures and estimation of public dose consequences.	ONR	A7.2
	Fire water reserve volumes.	ONR	
	Inclusion of maintenance within GDA.	ONR	A7.2
ABWR-10	Site vulnerability to flooding.	ONR	A7.3
ABWR-11	Consideration of storm surges.	ONR	A7.3
	Unexplained cancer cluster on both sides of the River Severn.	PHE	A7.2, A7.3
ABWR-12	Vulnerability to terrorist attacks and natural disasters.	ONR	A7.3
ABWR-15	Reassurance that technology will be safe and that improvements to design have been made.	ONR	A7.2

	Clarification of the basis for the 150 μSv/y dose constraint.	PHE	A7.2
ABWR-20	Validity of assurances.	Horizon	
ABWR-21	Standards for elimination of mistakes, rectifying and improving on errors.	ONR	
ABWR-22	Sufficiency of barriers to prevent fission products being transported in steam, through the turbine and being released to atmosphere via the condenser off gas system.	ONR	A7.2
ABWR-25	Use of ALARP for keeping worker exposure rates low.	ONR	
	Adequacy of emergency teams available on site at all times.	ONR	A7.2
ABWR-28	A flawed design with a number of long-term issues inadequately addressed.	ONR	A7.2, A7.3
	Inclusion of discharges and impacts as a result of failures or accidents (aqueous, gaseous, solid waste and groundwater).	ONR	A7.2
	Accident hazards presented by nuclear fuel and its products.	ONR	
ABWR-29	Failure to consider fault conditions and equipment failure, lack of probability risk assessment and need for re-design. Conclusions flawed as they only consider normal operations and not fault conditions after equipment failure.	ONR	A7.2
ABWR-30	Observations on safety and security will be made during consultation ahead of application for a Development Consent Order.	ONR	A7.2

Appendix 8 - Expectations for site-specific permitting

Any applications for site-specific permitting that rely on this GDA will also need to address the items specified below:

- how the Assessment Findings listed in Appendix 2 have been, or will be, addressed
- matters agreed as out of scope of this GDA, including:
    - environmental monitoring programme
    - reporting requirements in addition to those for significant nuclides, for example pollution inventory
    - BAT aspects of radioactive waste management facilities that were considered only to concept level in GDA and that operators need to develop at the detailed design stage
    - BAT aspects relating to operational decisions
    - impact of thermal discharges to surface waters
    - gaseous and aqueous discharges from the service building, dry solid LLW processing facility, ILW store and interim spent fuel store
    - cooling water abstraction intake screening
    - flood risk activities
- any extension to the scope of GDA, including:
    - provision of more than 1 reactor
    - non-coastal site
- any changes or developments to the design (as described in the design reference documentation specified in the SoDA), not addressed by Assessment Findings, that might affect environmental performance
- operator and site-specific matters including:
    - management system and arrangements, including the suitability of management systems for the installation
    - site-specific radiological assessments for people and non-human species, reflecting the local environment and the expected discharges taking account of all the matters above

Natural Resources Wales Customer Care Centre 0300 065 3000 (Mon-Fri, 9am-5pm)

Our Customer Care Centre handles everything from general enquiries to more complex questions about registering for various permits.

Email

enquiries@naturalresourceswales.gov.uk

By post

Natural Resources Wales c/o Customer Care Centre, Ty Cambria, 29 Newport Rd, Cardiff, CF24 0TP

Incident Hotline 0800 80 70 60 (24 hour service)

You should use the Incident Hotline to report incidents such as pollution. You can see a full list of the incidents we deal with on our 'Report an incident' page.

Floodline 0345 988 1188 (24 hour service)

Contact Floodline for information about flooding. Floodline Type Talk: 0345 602 6340 (for hard of hearing customers).

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