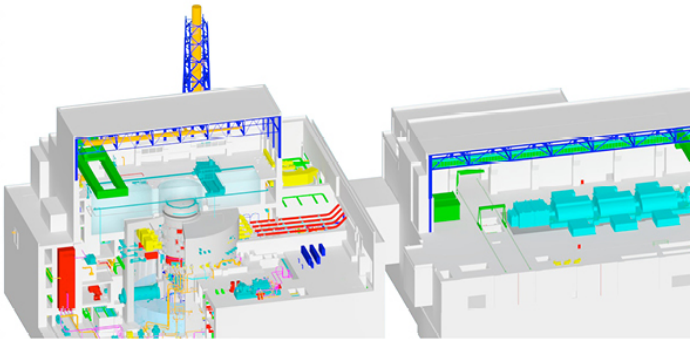
# Generic design assessment of nuclear power stations

Report on initial assessment of Hitachi-GE Nuclear Energy, Ltd's UK Advanced Boiling Water Reactor



August 2014

LIT 10001

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

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# Executive summary

This report sets out our initial findings from the first assessment stage of generic design assessment (GDA) for the UK Advanced Boiling Water Reactor (ABWR) nuclear power station design. This design was submitted for GDA by Hitachi-GE Nuclear Energy, Ltd (Hitachi-GE) (the 'requesting party').

GDA enables the Office for Nuclear Regulation (ONR) and the Environment Agency to begin assessing the acceptability of safety, security and environmental aspects of a nuclear power station design, at a generic level, before site-specific applications are made. It allows regulators to get involved at the earliest stage, when influence can be most effective. It also helps reduce regulatory uncertainty for designers and potential operators with consequent benefits for project timescales and costs. The Environment Agency and ONR work closely together throughout GDA, and in the subsequent regulation of any new nuclear power stations.

Natural Resources Wales (NRW) is also working closely with the Environment Agency on GDA to ensure that the outcome of the GDA for each reactor design, including any Statement of Design Acceptability (SoDA) or interim Statement of Design Acceptability (iSoDA) that may be issued, is applicable in both England and Wales.

Our assessment is carried out in two stages.

In the **initial assessment** we examine the requesting party's submission at an outline level. The aim is to identify whether we require further information, if there are any matters that are obviously unacceptable, and if any significant design modifications are likely to be required.

**Detailed assessment** is when we examine the submission in detail to come to a preliminary view on whether we might issue a SoDA, issue an iSoDA with identified GDA Issues (that is, significant but resolvable outstanding matters), or not issue either of these because the design is unsuitable. We will consult on our preliminary view and we will only make a final decision after we have carefully considered all of the responses received in that consultation.

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

The Environment Agency and NRW are responsible for regulating nuclear power stations in England and Wales respectively. Their regulation is carried out under several regulatory regimes. Our GDA focuses primarily on matters relevant to the disposal of radioactive waste. This is for two reasons:

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

However, we also, as far as is practicable at a generic level, address aspects of the design related to the other regulatory regimes.

The overall conclusions of the initial assessment for the UK ABWR nuclear power station design are:

- The submission does not adequately address all of our information requirements (as set out in our process and information document (P&ID) (Environment Agency, 2013)). Hitachi-GE has committed to providing the required information on a timescale that, subject to the information being of adequate quality, should enable us to maintain our indicative target of four years for completing a meaningful GDA.
- We have not at this stage identified any matters addressed by the submission that are obviously unacceptable.
- We have not at this stage identified any significant design modifications that are likely to be required.

- Hitachi-GE has an appropriate management system in place to control the content and accuracy of the information it provides for GDA.
- The annual radiation impact of the UK ABWR design on people would be below the UK constraint for any single new source.
- Based on the information we have at present, it is likely that radioactive discharges would not exceed those of comparable power stations.
- The generic site description is broadly consistent with the potentially suitable coastal sites identified in the nuclear national policy statement (UK Parliament, 2011a).

These conclusions are based on our initial assessment. Further or modified conclusions may be developed once Hitachi-GE has provided all the required information and we have carried out our detailed assessment.

We will only proceed to detailed assessment of the UK ABWR and subsequent consultation once we are satisfied that the regulators and Hitachi-GE are ready to do so.

At the regulators' request, Hitachi-GE has implemented a 'comments process' that enables people to view and comment on the GDA submission it has made (http://www.hitachi-hgne-uk-abwr.co.uk/make_a_comment.html).

# Contents

# 1. Introduction

## Purpose of this document

This report sets out our findings following the initial stage of generic design assessment (GDA) for the UK Advanced Boiling Water Reactor (UK ABWR) nuclear power station design. This design was submitted for GDA by Hitachi-GE Nuclear Energy, Ltd (the 'requesting party'), subsequently referred to as Hitachi-GE in this report.

## About GDA

The GDA process is not site-specific and has two stages, with increasing levels of detail. At the end of the GDA process, the Office of Nuclear Regulation (ONR) and the Environment Agency will decide if the proposed designs are acceptable. Natural Resources Wales (NRW) is also working closely with the Environment Agency on GDA to ensure that the outcome of the GDA for each reactor design, including any Statement of Design Acceptability (SoDA) or interim Statement of Design Acceptability (iSoDA) that may be issued, is applicable in both England and Wales. NRW's role in GDA includes participating in its governance, oversight, and decision making processes, and it is responsible for carrying out stakeholder engagement in Wales.

The GDA process is described in our process and information document (P&ID) (Environment Agency, 2013). GDA means that we assess the acceptability of the environmental aspects of a design, at a generic level, before site-specific applications are made. ONR has introduced a similar process for assessing the safety and security aspects of a design. We and ONR are working closely together. GDA allows the regulators to get involved with designers and potential operators at the earliest stage, where there can be the most influence and where lessons can be learned that may be applicable to other submitted designs. This early involvement also reduces regulatory uncertainty for designers and potential operators.

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

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

Our assessment is carried out in two stages.

In the initial assessment, we examine the requesting party's submission at an outline level. Our aim is to identify whether we require further information, if there are any matters that are obviously unacceptable, and if any significant design modifications are likely to be required. Detailed assessment is when we examine the submission in detail to come to a preliminary view on whether we might:

- issue a Statement of Design Acceptability (SoDA)
- issue an interim Statement of Design Acceptability (iSoDA) together with identified GDA Issues (a GDA Issue is a significant, but resolvable outstanding matter)
- not issue either of these because the design is unsuitable

We will only make a final decision after consultation and consideration of all the responses received.

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

GDA work is carried out under an agreement we made with the requesting party under Section 37 of The Environment Act 1995 (EA95). We commenced GDA for the UK ABWR following the signing of this agreement in April 2013.

The Environment Agency regulates nuclear power stations in England and NRW regulates nuclear power stations in Wales, under several regulatory regimes, as set out in the next section. Our GDA focuses primarily on matters relevant to the disposal of radioactive waste, for two reasons:

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

Apart from flood defence, which is a site-specific matter, we also, as far as is practicable at a generic level, address aspects of the design related to the other environmental regulatory regimes.

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

## Regulation of nuclear power stations

We regulate several aspects of the operation of nuclear power stations in England (the same aspects are regulated by NRW for stations in Wales):

- The disposal of radioactive waste requires a permit under 'The Environmental Permitting (England and Wales) Regulations 2010' (as amended) (EPR10).
- The discharge of other aqueous effluents (such as from cooling, or dewatering during construction) requires a permit under EPR10.
- Some conventional plant (for example combustion plant used as auxiliary boilers and emergency standby power supplies, and incinerators used to dispose of combustible waste) may require a permit under EPR10. Some combustion plant may also need a permit under 'The Greenhouse Gas Emissions Trading Scheme Regulations 2012' (as amended).
- The disposal of waste by depositing it on or into land, including excavation materials from construction, and other waste operations may require a permit under EPR10.
- The abstraction of water (for example, for cooling or process use) from inland waters or groundwater, except in some specific circumstances, requires a licence under 'The Water Resources Act 1991' (WRA91). Inland waters include rivers, ponds, estuaries and docks, amongst others.
- The construction of new or enhanced flood defence structures, or modification of existing ones requires a flood defence consent under WRA91.
- The Environment Agency and the Health and Safety Executive together form the competent authority for 'The Control of Major Accident Hazards Regulations 1999' (COMAH99). On-site storage of certain substances may fall under these regulations.

# 2. The UK ABWR design

This section provides a brief outline of the design and how wastes are proposed to be created, processed and disposed of.

## Outline of design

The UK ABWR design is for a single, generation III+, boiling water reactor (BWR) capable of generating 1350 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 light 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 main ancillary facilities include a spent fuel storage pool, spent fuel store (final option not yet selected), water treatment systems for maintaining the chemistry of the water circuit, two alternative AC generators 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.

The International Atomic Energy Agency (IAEA) Power Reactor Information System (PRIS) database notes that there are four units of the ABWR already operating in Japan with a further four units under construction in Japan and Taiwan. The ABWR design has undergone design assessment by the nuclear regulators in the United States of America (USA), Japan and Taiwan. The design has evolved from earlier Hitachi-GE BWR designs and the ABB design, transferred under licence to Hitachi-GE / Toshiba. The most recent reactor of similar design is the BWR-6, of which there are eight units currently operating around the world.

## Sources, processing and disposal of radioactive waste

Radioactive wastes arise from activities associated either directly or indirectly with operation and maintenance of the reactor, and ultimately, from decommissioning of the power station. In particular, operation of the UK ABWR leads to the generation of radioactive waste in the water of the reactor coolant circuit.

Liquid radioactive discharges arise mainly from effluents associated with systems for the collection and treatment of the reactor coolant water. Other sources of effluent include the washings from plant decontamination, drainage from change-rooms and effluent from the active laundry. Liquid effluent treatment facilities include tanks for the accumulation, hold up and monitoring of wastes, filters, demineraliser ion exchange resin beds and evaporators. Facilities to monitor effluents prior to release are provided.

The principal 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, ventilation and air-conditioning systems (HVAC). Discharges from these systems are via high level stacks located on the top of the reactor building. There is provision for monitoring these discharges after filtration.

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. Management facilities for these solid wastes include: resin storage tanks and storage areas for packaged low-level and intermediate-level radioactive wastes. Space has been included for provision of treatment and packaging of solid wastes. All radioactive plant components are likely to become waste when the power station is decommissioned. Similar wastes arising 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).

Spent fuel will be stored under water for several years in the spent fuel storage pool. The design includes space for provision of a store to allow further storage prior to ultimate disposal.

## Non-radioactive wastes

Non-radioactive wastes arise from operation and maintenance of 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

Further information on the management of non-radioactive waste will be provided in future submissions from Hitachi-GE.

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

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

## Process

The P&ID (Environment Agency, 2013) sets out in detail the process that we follow during GDA. This section details the steps we have taken during the initial stage of GDA for the UK ABWR design.

We established an agreement with Hitachi-GE, under Section 37 of EA95, to carry out and recover our costs for GDA of the UK ABWR design. This came into effect on 2 April 2013. We set out, jointly with ONR, a timetable for this initial stage of the work, that is, our initial assessment and ONR's Step 2 assessment. This commenced with provision of the submission by Hitachi-GE on 1 April 2014. Between April 2013 and April 2014, we provided advice on the contents of the submission and agreed detailed working arrangements, covering matters such as document identification and tracking, and the review process.

The regulators' JPO received the submission on 1 April 2014 with some documents being revised and resubmitted a little later. The individual documents making up the submission, which were assessed by us in the initial assessment, are listed in Annex 1.

Hitachi-GE's 'comments process' (required by the regulators) was launched on 6 January 2014, to enable people to view and comment on the GDA submission. As part of this process:

- Information about GDA and the comments process, with links to Hitachi-GE website, has been provided on the GDA New Reactors website (http://www.onr.org.uk/new-reactors/index.htm).
- Hitachi-GE has published its submission (apart from any sensitive nuclear information or commercially confidential information) and a non-technical summary on its website. There is provision for comments to be made electronically, or by post, to Hitachi-GE.
- Hitachi-GE and the JPO have provided electronic copies on compact disc of the submission and paper copies of the summary to members of the public, on request.

Hitachi-GE and the regulators have publicised the submission and the comments process by the following means:

- Hitachi-GE has published its submission documents on its Hitachi-GE GDA website and invited comments on the submission.
- The regulators updated the GDA 'new reactors' website to reflect that our initial assessment had begun and included links to Hitachi-GE's website and its comments process.
- The regulators issued a news story on 6 January 2014 which was reported in trade, business and energy media. The information was also reported in Welsh newspapers and news websites.
- Hitachi-GE undertook a significant programme of direct engagement to raise awareness of the comments process, with letters sent to UK MPs, government figures, members of the Welsh Assembly, selected peers, all UK councils, leaders of site stakeholder groups (SSGs) and local community liaison councils (LCLCs), the Snowdonia National Park Authority, and a range of further stakeholders around proposed UK ABWR development sites.
- We posted information about GDA and the comments process on GOV.UK and both regulators used social media (Twitter and LinkedIn).
- The regulators have published quarterly reports since the beginning of GDA on the UK ABWR. Quarterly reports highlight the key challenges and describe how the assessment is progressing.
- The regulators have issued e-mail updates to subscribers. (http://www.onr.org.uk/new-reactors/ebulletin.htm).

- The regulators have published their proposed approach to public and stakeholder engagement and welcome comments on this.

Comments received up to 31 May 2014, and Hitachi-GE responses to those comments, have been considered by the appropriate regulator during the initial assessment stage. Comments received after 31 May 2014 will be considered during the next stage of assessment.

Throughout the assessment process, questions can be raised by the regulators to Hitachi-GE using a tiered approach dependent of the potential significance of the information requested as follows:

- A Regulatory Query (RQ) is raised for clarification and additional information and is not necessarily indicative of any perceived shortfall.
- A Regulatory Observation (RO) is raised for a potential regulatory shortfall and requires action and new work for it to be addressed. Each RO can have several associated actions. ROs will be published on the joint regulators' website.
- A Regulatory Issue (RI) is raised for a serious regulatory shortfall which is potentially significant enough to prevent provision of a SoDA or an iSoDA. This requires action and new work for it to be addressed. Each RI can have several associated actions. RIs will be published on the joint regulators website.

It is possible that a question raised as a RQ could escalate to a RO or to a RI.

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

## Next steps

Our next step is to commence the detailed assessment to come to a preliminary view on whether we might issue a SoDA, issue an iSoDA with identified GDA Issues, or not issue either of these because the design is unsuitable. To do this assessment, we will need the further information identified in Annex 2.

Hitachi-GE will make this further information available to the public in the same way as the initial submission, along with that required by ONR for its Step 3 assessment. This will not include any sensitive nuclear information or commercially confidential information. Comments on this further information will also be invited.

On completion of the detailed assessment, we will consult widely on our preliminary view. We expect to begin this public consultation in March 2016 (date may be subject to change). We will carefully consider all responses to the consultation before deciding whether or not to issue a SoDA or an iSoDA. We expect to report our decision in December 2017.

## Comments on our process

One comment was received that related to the GDA process itself. The comment suggested that the GDA should consider the whole 'life time' design including eventual decommissioning and disposal of waste, including low level radioactive waste. There was a specific question regarding where the waste would be taken.

We have responded that during the GDA of the UK ABWR, we will assess Hitachi-GE's plans for how it will manage and dispose of radioactive wastes and spent fuel throughout the whole lifecycle of the power station. For the purposes of GDA, the waste routes are assumed to be those currently available with the addition of a geological disposal facility (GDF) in line with UK government policy. The disposability will be assessed in greater detail as GDA progresses.

# 4. Initial assessment - in more detail

As indicated in the P&ID (Environment Agency, 2013), our initial assessment has involved a more detailed examination of three aspects of the submission:

- the Hitachi-GE management system for production of the submission
- the generic site description
- the assessment of the impact of proposed radioactive discharges

The management system is discussed in Section 4.1. The generic site characteristics that are of interest to us are, principally, those that are relevant to the estimation of the impact of discharges of radionuclides and non-active substances, and of cooling water abstraction and discharge. There is considerable overlap between the generic site description and the assessment of the impact of proposed discharges and these two aspects are considered together in Section 4.2.

## 4.1. Hitachi-GE management system

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

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

Hitachi-GE's submission describes the management system in:

- the GDA Project Plan
- the Quality Management Plan (for UK ABWR GDA Project)
- the Compliance Table for Regulatory Expectations
- eight of the GDA specific procedures

Hitachi-GE has a quality management system (QMS) which is certificated to ISO 9001:2008 and has developed specific management system arrangements for the GDA project. These are intended to control the development, review, independent review and approval of the safety, security and environmental submissions and deliver the regulators' expectations for GDA.

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

- check that Hitachi-GE has a 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

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

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 JPO. A number of minor discrepancies were found. Records were well specified and kept. We judged the document control arrangements to be satisfactory.
- 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.
- 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. One important area for improvement was identified, relating to how the impact on nuclear safety and the use of Best Available Techniques (BAT) are discussed and considered during design review meetings and how this is recorded in the minutes.
- 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.
- Suitably Qualified and Experienced Personnel (SQEP) records were examined for Hitachi-GE personnel, contractors and consultants and 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.
- Radioactive Waste Advisers (RWAs) had not been appointed at the time of the inspection. However, examination of role profiles indicated that training on our requirements and the use of BAT had been given to relevant staff. This is judged sufficient at this stage of the project. Hitachi-GE has plans to use RWAs in the next stage of GDA and we may revisit this at a later date.
- 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 focussed on system requirements. We made a recommendation to focus the next round of audits on GDA deliverables and to carry out the audits near the start of the next stage of GDA, to allow time for corrective action.
- Hitachi-GE is considering how it will meet the expectations given in Guidance to Requesting Parties (ONR, 2013) and the P&ID (Environment Agency, 2013) for the next stage of GDA. Hitachi-GE has agreed to produce a table showing how it plans to meet the expectations.
- During the inspection, additional meetings were held 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 2000 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.

The details of the inspection were recorded in a joint inspection report (ONR-GDA-IR-13-001, revision 0) and the main findings were recorded as areas for improvement:

- Hitachi-GE should include the arrangements for controlling the GDA contact list in the Document Control Manual.
- Hitachi-GE should retrospectively add the existing RQs, ROs and other documents (for example Management Surveillance and Quality Assurance procedures) to the submission tracking sheet and ensure such documents are included in the future.

A joint Environment Agency and ONR RQ was raised with Hitachi-GE to address the main findings of the inspection (RQ-ABWR-0092).

Hitachi-GE has responded to the requirements of the RQ. After consideration of Hitachi-GE's responses we concluded that these were adequate, other than we will require further evidence that consideration of BAT in the design control process would be adequately recorded.

In conclusion, we are satisfied that Hitachi-GE has developed and implemented a suitable management system for the GDA project which, based on the sample taken, should ensure that our and ONR's expectations for GDA are fulfilled and that environmental and safety documentation is produced which has been adequately reviewed and independently verified. It should be noted that the quality of the content of the safety and environmental documentation will be determined by discussions held between the regulators and Hitachi-GE's subject matter experts.

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

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

## Site characteristics

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

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

Hitachi-GE's submission discusses the generic site in 'Generic Site Description' (GA91-9901-0020-00001 revision C). This document provides an overview of the parameters used in the assessment of the radiological impacts from the UK ABWR. These parameters include: meteorological data, hydrographic data, location of food production and human habitation, habit data, and other geographical information. The list of reference organisms used to assess radiological impacts to non-human biota is also provided, although Hitachi-GE has stated that for GDA, it is assumed that no designated sites are located in the vicinity of the generic site. The generic site is coastal and for the purposes of GDA, Hitachi-GE has assumed that the UK ABWR will be once-through sea water cooled, and does not require fresh water abstraction for cooling.

Most of the parameters used are generic for the UK and are appropriate for use in GDA of the UK ABWR. However the selected local compartment volumetric exchange rate (1300 cubic metres per second ($m^3/s$)) used in the stage 2 refined radiological assessment is the value for Wylfa on the North Wales coast. In addition, the regional compartment data used in the detailed radiological assessment are for Irish Sea West (corresponding to the area around Wylfa). The dose to members of the public from liquid discharges is sensitive to the volumetric rate used. However, the overall doses from liquid discharges are very small because the amount of radioactivity discharged via this route is small, with the majority of radioactivity being discharged via gaseous discharges from the main stack. A stage 1 initial radiological assessment has also been undertaken by Hitachi-GE, using a lower volumetric exchange rate (100 $m^3/s$) which bounds all the possible new build sites in the UK.

During our initial assessment, three RQs were raised to clarify information supplied in the 'Generic Site Description' submission document. These requested clarity on the contents of tables, sources of data and the volumetric exchange rate used for different stages of the radiological assessment (RQ-ABWR-0067 to RQ-ABWR-0069). Hitachi-GE has provided satisfactory responses to all of these RQs and the RQs are closed.

The coastal nature of the generic site and the use of once-through direct cooling will limit the applicability of any future SoDA to a site with these characteristics.

## Dose assessments

Our P&ID (Environment Agency, 2013) asks the requesting party to provide dose assessments including:

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

The submission provides a dose assessment for the public in document 'Prospective dose modelling' (GA91-9901-0026-00001, revision C). This document addresses the requirements given above. The document provides considerable detail on the approach to dose assessment and presents the results based on the proposed dose limits.

## Preliminary dose assessment

Our preliminary assessment of the dose assessment document indicates that Hitachi-GE has followed the recommended methodology in our dose principles document (Environment Agency et al. 2012). The dose principles document proposes a staged assessment – starting with an initial assessment using an appropriate screening tool, followed by more refined and detailed dose assessments.

Hitachi-GE has undertaken a three stage dose assessment. Results for individual doses are presented in the document, for each of the assessment stages. The assessed doses may be considered as likely to be indicative of the dose to the representative person.

As required by the dose principles document, Hitachi-GE has provided:

- an assessment of collective doses from discharges
- an assessment of the predicted build up of radionuclides in the environment with time
- an assessment of doses from possible short duration releases of radionuclides to atmosphere

## Individual doses

The predicted doses for each stage of the assessment calculated by Hitachi-GE are summarised in Table 1.

The stage 1 dose assessment provides an upper bounding estimate of potential doses to the public. This is calculated using conservative assumptions about the initial dispersion of the release, habits and locations of exposed groups. The assessment considers four age groups and presents the highest dose to any of them.

For gaseous releases, the assessment assumes a ground level release – which results in the highest air concentrations at ground level. Other assumptions are that people live 100 metres (m) from the release point and eat a lot of local foods produced 500 m from the release point. Therefore, the outcome from the stage 1 initial radiological assessment is likely to be the highest predicted doses. For liquid releases, the assessment assumed that discharges occur into the coastal environment where immediate dispersion by water is at a low level (100 $m^3/s$). Other assumptions are that large amounts of fish and shellfish are caught from close to the release point and eaten. Therefore, the outcome from a stage 1 initial radiological assessment is likely to be the highest predicted doses.

Doses from gaseous discharges, liquid discharges and direct radiation are calculated and the outcomes summed for the most exposed age groups. The highest total dose is 311 µSv/y - made up of dose to infant of 149 µSv/y from atmospheric discharges (mostly carbon-14 in milk), a small dose to adults from liquid discharges (2 µSv/y) and doses to adults from off-site direct radiation (160 µSv/y). The total dose is for an individual who is a combined age group of adult and infant.

**Table 1 Estimates of dose (made by Hitachi-GE) for exposed groups from discharges and direct radiation at the proposed annual limits.**

| Assessment stage | Age group | Doses (age groups) to the public µSv/y* | | | |
|---|---|---|---|---|---|
| | | Gaseous | Liquid | Direct | Total |
| **Stage 1 – initial assessment** | Infant and adult | 149 (infant) | 2 (adult) | 160 (adult) | 311 (adult/infant) |
| **Stage 2 refined assessment** | Infant and adult | 22 (infant) | 0.16 (adult) | 160 (adult) | 182 (adult/infant) |
| **Stage 3 detailed assessment** | Adult | 11.5 | 0.005 | 31 | 42.5 |
| | 10 year old | 15.1 | 0.005 | 15.5 | 30.6 |
| | 1 year old infant | 29.2 | 0.001 | 10.5 | 39.7 |

* micro-Sieverts per year

The stage 2 dose assessment has been undertaken with a less conservative initial dispersion for the gaseous discharges and liquid discharges. For gaseous releases, an effective release height of 19 m above ground level was assumed. The physical stack height that will be used is as yet undecided, but an indicative height of 57 m has been adopted. Taking into account the effect of buildings on the released plume from the stack – 19 m is an appropriate effective height for the modelling. Other assumptions are unchanged - that people live 100 m from the release point and eat a lot of local foods produced 500 m from the release point. For liquid releases, the assessment assumed that discharges occur into the coastal environment. The immediate dispersion by water was increased to 1300 $m^3/s$ – the value for Wylfa located on the North Wales coast. Other assumptions that large amounts of fish and shellfish are caught close to the release point and eaten remain in use. All other inputs were unchanged from stage 1.

As a consequence of the increased dispersion - the estimated doses are reduced to 182 µSv/y. Doses from gaseous discharges to atmosphere are reduced to an infant to 22 µSv/y, 0.2 µSv/y to an adult from liquid discharges and 160 µSv/y to an adult from direct radiation. The total dose is for an individual who is made up from a combined age group of adult and infant.

The stage 3 dose assessment has been undertaken using the PC-CREAM 08 ® model. This model comprises of a number of modules that predict the transfer of radionuclides in the environment, the pathways by which people may be exposed to radiation and the resulting radiation doses received. The model was used to predict the build up of radionuclides in the environment around the release point. The model allows the location of people in the environment to be changed also.

For gaseous discharges, the effective release height has been retained at 19 m above ground level. Several models within PC-CREAM 08 were run – an atmospheric dispersion model, followed by a deposition and re-suspension model and models to predict dose rates from soil and concentrations in pasture, animal products, crops and fruit. The model duration was based on the proposed operational life of the reactor, 60 years. Other key assumptions are that people live 300 m from the release point and eat a lot of local foods produced 500 m from the release point. The food consumption rates are lower than in the stage 1 and stage 2 dose assessments because they are based on a standard methodology (the so called ‘top-two’ method).

For liquid discharges, the assessment of the radiological impact of liquid discharges was undertaken using a marine dispersion model which calculates the concentration of radionuclides water and sediment and fish, shellfish and seaweed and a model to predict dose from exposures

to sediments and consumption of marine foods. The site parameters, including local compartment water exchange rates, suspended sediment loads and other parameters, are input. For this assessment the default values for the marine environment around the Wylfa site in North West Wales were used. The annual discharge rates and exposure routes are defined and the individual doses for each age group, calculated for high consumption and mean consumption rates. Environmental concentrations and doses were calculated for a continuous discharge over 60 years, corresponding to the proposed operational life of the reactor.

The estimated total dose is presented for the three age groups separately. The highest dose is to an adult (42.5 µSv/y), of which 31 µSv/y is from direct radiation and 11.5 µSv/y from gaseous discharges. Dose to infants (39.7 µSv/y), of which 10.5 µSv/y is from direct radiation and 29.2 µSv/y from gaseous discharges. Predicted dose to a child is lower, at 30.6 µSv/y. The reduction in dose received from direct radiation between the stage 1 and 2 dose assessments and the stage 3 dose assessment is due to an increase in assumed habitation distance from the source, from 100 m to 300 m.

At each stage, the contributions from direct radiation and gaseous discharges to doses offsite are shown to be important. The dose from gaseous discharges is dominated by the expected discharges of carbon-14. We have asked for additional information on the source term and expected discharges in a Regulatory Observation (Regulatory Observation RO-ABWR-0006 – source term, see Section 5.2).

Doses from liquid discharges are very low in all cases. This is because the quantity of radioactivity discharged in liquid waste is expected to be small.

## Criteria

There are a number of dose limits and constraints that any new nuclear power station would have to meet.

The source dose constraint (UK Parliament, 2010) is 300 µSv/y. It applies to the dose from proposed discharges and direct radiation from a new single source. The assessed total annual doses (from discharges and direct radiation) to the representative person from the stage 2 and 3 assessments (182 µSv/y and 42 µSv/y) are both within the source constraint.

The site dose constraint (UK Parliament, 2010) is 500 µSv/y. It applies to the total dose from the current discharges from all sources at a single location, including discharges from immediately adjacent sites – doses arising from direct radiation and historical discharges are not included. All the sites listed in NPS EN-6 (UK Parliament, 2011a) as potentially suitable for a new nuclear power station are adjacent to existing nuclear sites. Of these, Sellafield has the highest assessed dose for discharges at currently permitted discharge limits, at 50 µSv/y from gaseous discharges and 183 µSv/y from liquid discharges. Adding this to the assessed dose (stage 3) from discharges for the UK ABWR of 29 µSv/y gives a value of 79 µSv/y from gaseous discharges and 262 µSv/y from liquid and gaseous discharges. All are within the site dose constraint.

The dose limit (UK Parliament, 2010) for members of the public is 1000 µSv/y. It applies to the total dose from the future discharges from the site, direct radiation from the site, future discharges from other sources near the site, direct radiation from other sources near the site, and the residue of radioactivity in the environment from past discharges. Of the sites listed in NPS EN-6 (UK Parliament, 2011a), Sellafield also has the highest dose from direct radiation and historic discharges, at 300 µSv/y (Environment Agency et al, 2013). This value includes the contribution from a phosphate works near Whitehaven. Adding this to the assessed total dose for the UK ABWR of 42 µSv/y (from discharges and direct radiation); the assessed dose for Sellafield discharges at the current permitted limits of 183 µSv/y (liquid) and 50 µSv/y (gaseous) gives a value of 575 µSv/y, which is within the dose limit.

Hitachi-GE has stated that the UK ABWR is not susceptible to large variations in activity concentrations in the reactor coolant. However fluctuations may arise due to expected events, such as fuel pin failures, during the proposed operational lifetime of the reactor. The activity discharged to air as a result of a fuel pin failure has been estimated. The expected releases are of isotopes of iodine, xenon and krypton at about 65% of the proposed annual limits. The release is

expected to occur over a 24 hour period and only once during the lifetime of the power station. The assessed dose for this situation was between 2.5 and 7.5 µSv (see Table 12.3-1 in the prospective dose modelling submission). Therefore, a fuel pin failure would not be expected to result in the impact exceeding the source constraint, site constraint or dose limit.

We raised 23 RQs on the 'Prospective Dose Modelling' submission. The RQs ranged from questions about reference documents, to questions related to the methodologies and models used and the interpretation of the results. The RQs are summarised below (Table 2) and all are now closed.

**Table 2 Regulatory queries raised on the prospective dose modelling document**

| RQ - ABWR - | Proposed resolution date | Content |
|---|---|---|
| **0061** | 10-4-14 | Reason for use of caesium-137 as a surrogate for other radionuclides in the source term for the assessment is needed. |
| **0062** | 10-4-14 | Predicted build up of radionuclides in the environment with time – reason for selection of radionuclides to present in the figures is needed. |
| **0063** | 10-4-14 | Calculation of doses to the foetus is needed for the detailed assessment. |
| **0064** | 10-4-14 | Reason for differences in dominant radionuclides (in terms of dose) between the Japanese ABWR and UK ABWR is needed. |
| **0065** | 10-4-14 | Sources of information for expected discharges are not referenced correctly. |
| **0066** | 10-4-14 | The method for undertaking a “top 2” dose assessment is not presented. |
| **0108** | 30-5-14 | Inconsistent presentation of particulate releases from short term releases. |
| **0109** | 30-5-14 | Provision of references to support statements concerning a scaling factor. |
| **0110** | 30-5-14 | Clarification of the reason for selection of 57 m for the stack height for the UK ABWR is needed. |
| **0111** | 30-5-14 | Clarification of footnotes to tables is needed. |
| **0112** | 30-5-14 | Consideration of appropriate radionuclides to be shown in figure of seabed sediment concentrations is needed. |
| **0113** | 30-5-14 | A more complete justification to support the statement that ‘it is concluded that the predicted radiological consequences will be independent of the duration of the discharges beyond 30 yr’ is required. |
| **0114** | 30-5-14 | More information is needed on which “radionuclides are of interest” and why they are of interest. |
| **0115** | 30-5-14 | Consideration of appropriate radionuclides to be shown in figure of soil concentrations is needed. |
| **0116** | 30-5-14 | Justification of the use of PC-CREAM 08 for the stage 3 assessment is needed. |
| **0117** | 30-5-14 | Clarification of figure legends is needed. |
| **0118** | 30-5-14 | Direct radiation exposure of the Fisherman family - reason why |

| RQ - ABWR - | Proposed resolution date | Content |
|---|---|---|
| | | this has not been assessed is needed. |
| **0119** | 30-5-14 | The relationship between Pasquill's stability categories and the ADMS 5 model needs to be explained. |
| **0120** | 30-5-14 | Clarification of the skin dose calculation methodology is needed. |
| **0121** | 30-5-14 | Explanation of the environmental concentrations from short duration releases needs to be extended. |
| **0122** | 30-5-14 | Explanation of the collective dose results needs to be improved. |
| **0123** | 30-5-14 | Dose criteria and their application to prospective dose assessment in GDA needs to be presented more clearly. |
| **0124** | 30-5-14 | The explanation of the potential impact on the future use of sea or land needs to be made clearer. |

## Direct radiation

Hitachi-GE's submission includes a section on doses to the public from off-site direct radiation from the site. The dose assessment outcome from direct radiation should be included in the overall dose assessment for members of the public in an appropriate way. We have passed the section on off-site direct radiation from the reactor to ONR for review.

During the initial review, the Interim Spent Fuel Storage (ISFS) has been identified as a possible additional source of direct radiation exposure of the public. Therefore, there will be a need to assess this appropriately and include this component in the overall assessment of dose to the public. A RQ has been raised by ONR which refers to the ISFS (RQ-ABWR-0174 - radiation protection aspects associated with ISFS).

## Source term

The source term, in the context of GDA, means the types, quantities, and physical and chemical forms of the radionuclides present in a nuclear facility that have the potential to give rise to exposure to radiation, radioactive waste or discharges. For the dose assessment related to the public, the source term that is related to radioactive discharges is the most important. The specific elements that are of interest are the radionuclides and amounts that will be discharged to atmosphere as gases, mists and dusts and to water as liquids.

In its submission, Hitachi-GE has identified the expected discharges of radionuclides to air and water and proposed annual discharge limits to form the normal operation source term, and made the dose assessment using this information.

A RO has been raised on the source term (Regulatory Observation RO-ABWR-0006 – source term, see Section 5.2). The resolution of this RO may result in changes to the expected discharges which in turn may lead to changes to the dose assessment outcome. Therefore, resolution of the source term RO will be fundamental to the final dose assessment for use in the detailed assessment stage.

## Protection of the environment

Hitachi-GE used environmental concentrations predicted by the PC-CREAM 08 model as inputs to the ERICA model to assess the impact on non-human species. The R&D128 assessment tool was also used to assess the impact of noble gases on non-human species.

We use an action level of 40 µGy/h. This is the dose rate below which we consider there will be no significant adverse effects on the integrity of protected Natura 2000 sites. Because non-human

species may be affected by discharges from more than one site, we also use a screening level of 10 µGy/h, when considering the impact from a single source.

The calculated dose rates for discharges to the marine environment (based on stage 3 dose assessment outputs) were up to 1.4 µGy/h, the highest dose rate being to marine mammals. For gaseous discharges, excluding noble gases, the highest dose rate was 5.3 µGy/h to birds, reptiles, large terrestrial mammals such as deer, and small terrestrial mammals such as rats. This assessment assumed that gaseous discharges were released at ground level. In reality, gaseous discharges will be released from a stack located on the roof of the reactor building. When the assessment was refined to account for this, the maximum dose rate to any terrestrial organism was 0.24 µGy/h.

The maximum dose rate to any terrestrial organism resulting from discharges of noble gases was found to be 0.03 µGy/h.

Doses to all organisms are below the 10 µGy/h screening level.

We had not received any comments relating to the generic site or dose assessment for the UK ABWR design by 31 May 2014.

## Preliminary conclusion

Our preliminary conclusion is:

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

However, there are a number of issues with the assessment which require further work as identified in RQs and other key inputs related to the source term, which are subject to further work by a RO.

# 5. Initial assessment – principle level

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

## 5.1. Radioactive waste management arrangements

Our P&ID (Environment Agency, 2013) asks the requesting party to provide a detailed description of the radioactive waste management arrangements, primarily addressing the three aspects discussed below.

### Strategic considerations

We ask the requesting party to identify the strategic considerations, with respect to radioactive waste management, that underpin the design. Our REPs (Environment Agency, 2010a), at principle RSMDP1 (Radioactive substances strategy), indicate the matters to be considered. Additionally, the government has indicated that new nuclear power stations should proceed on the basis that spent fuel will not be reprocessed, and that both spent fuel and intermediate level radioactive waste will be disposed of to a GDF that the government will construct (UK Parliament, 2011b). Since such disposals are unlikely to occur until late this century, this effectively means that the strategy needs to include provision for on-site storage of both intermediate level waste (ILW) and spent fuel for the lifetime of the power station, or an appropriate alternative.

Hitachi-GE's submission refers to strategic considerations in 'Radioactive Waste Management Arrangements' (RWMAs) (GA91-9901-0022-00001, revision C). In that document, consideration of our REPs (given in Annex A of the document), Hitachi-GE states that the whole document covers the considerations of RSMDP1. Our views on the presentation of the strategic considerations relating to radioactive waste management from our 'principle' level assessment are that the RWMAs:

- are logically set out and derived from clearly stated objectives and principles
- address, insofar as they can at this stage, the requirements set out in RSMDP1
- give due consideration to the use of the waste management hierarchy in decision making processes involving radioactive wastes
- give due consideration to the use of BAT to minimise the production of radioactive waste
- do not describe or address, as they are presented, any management arrangements associated with liquid or gaseous effluents

Hitachi-GE will propose a preferred interim storage option for spent fuel arisings for GDA purposes, as outlined in 'Preliminary Safety Report on Spent Fuel Interim Storage' (GA91-9901-0045-00001 revision A). This will seek to provide assurances that spent fuel can be safely managed prior to geological disposal. The timescales for interim storage will be dictated, at least in part, by the required cooling time prior to final disposal. Any preferred interim storage option will not constrain future site operators, who may select other arrangements subject to regulatory approvals at that time. Options under consideration for GDA comprise:

- concrete cask storage
- metal cask storage
- wet (pool) storage
- vault storage

ILW will be managed through interim storage and disposal to the GDF, pending disposability assessments, which is in line with our expectations.

Our conclusion, at the principle level, is strategic considerations are adequately addressed.

## Identification of radioactive waste arisings and proposals for management and disposal

We ask the requesting party to describe how radioactive wastes and spent fuel will arise throughout the facility's lifecycle (including decommissioning) and the plans for managing and disposing of them.

Radioactive species are generated within the UK ABWR via a number of mechanisms and processes which are summarised below:

- Fission of fuel fissile material
- Fission of tramp uranium
- Activation of structural components
- Activation of coolant, both coolant water and any dissolved or suspended impurities
- Activation of fuel components or intrinsic impurities
- Ternary fission in fuel
- From secondary neutron sources
- From boron in the control rods
- Secondary wastes from the treatment of liquid effluents (filters and resins)

These are described in more detail in 'Demonstration of BAT' (GA91-9901-0023-00001, revision C) and 'Radioactive Waste Management Arrangements' (GA91-9901-0022-00001, revision C).

With the exclusion of neutron-activated structural materials and potentially contaminated oils, all radioactive species produced in the UK ABWR are effectively transported around the plant in solution or suspended in the primary coolant. The UK ABWR design treats waste liquids carrying radioactivity as either high-conductivity waste (HCW) (those with the most conductive impurities) or low-conductivity waste (LCW) (those with fewer conductive impurities). The treatment regime for HCW is by evaporator and demineraliser for reuse within the plant where possible. Processed waters from HCW are only discharged to maintain the water balance. LCW is treated by filter and demineraliser, and all of processed water is reused within the plant.

Gaseous effluent is generally produced from off-gassing dissolved or entrained gases from within the primary coolant. This happens in the off-gas system (OG). From an abatement perspective, the OG has two functions: to remove particulate and volatile species from gaseous effluent, by either high efficiency particulate air (HEPA) or activated charcoal filtration; and to minimise the discharge of noble gases using carbon delay beds. Once treated, the OG discharges gaseous effluent to atmosphere via the stack.

As with all light water moderated reactors, solid waste (other than spent fuel) is formed by two mechanisms:

- Direct neutron activation of structural materials
- Contamination of materials which have come into contact with coolant carrying
    - dissolved activation products from structural materials
    - activation products from the direct neutron activation of the coolant
    - fission products resulting from failed fuel
    - fission products from tramp uranium

Hitachi-GE propose to dispose of other low level waste (LLW) streams through the use of the Low Level Waste Repository (LLWR) Ltd contract service, however, this does not constitute a demonstration of BAT.

The submission addresses the creation rates for various solid waste streams ranging from spent fuel to very low level waste very comprehensively in 'Radioactive Waste Management Arrangements' (GA91-9901-0022-00001, revision C) based on operating experience from other ABWRs.

Our conclusions, at the principle level, are:

- all likely sources of radioactive waste have been identified
- feasible management and disposal plans have been identified for each waste stream
- the analysis of BAT requires further development

For the detailed assessment, we will need improved information to be provided.

## Protection of people and the environment

We ask the requesting party to describe how the production, discharge and disposal of radioactive waste will be managed to protect the environment and to optimise the protection of people. We expect Hitachi-GE to do this by demonstrating that its management and disposal plans (as discussed previously) represent use of BAT. In justifying techniques as BAT, the requesting party should address:

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

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

The GDA submission specifically addresses BAT in the documents, 'Approach to Optimisation' (GA91-9901-0021-00001 revision C) and the 'Demonstration of BAT' (GA91-9901-0023-00001 revision C). Hitachi-GE's document entitled, 'Approach to Optimisation' (GA91-9901-0021-00001 revision C), describes how a 'claims – argument – evidence' approach will be used in demonstrating the application of BAT for GDA purposes. We feel that this approach provides a workable framework.

Hitachi-GE's 'Demonstration of BAT' (GA91-9901-0023-00001 revision C) document provides only claims and arguments. Evidence will be provided progressively during the detailed assessment stage.

To date we have provided informal responses on the developing BAT approach. Early feedback has focussed on the clarity, balance and relevance of the claims and arguments as presented. We expect to see both the positive and negative aspects of particular options and approaches outlined.

Based on our initial assessment of the BAT claims and arguments, and prior to the detailed assessment, we note the following as important, high level aspects for further consideration:

- The design of the OG and the optimised application of abatement techniques to minimise environmental impacts from gaseous discharges.
- Features of the design that are consistent with a "concentrate and contain" approach, such as the clean-up and reuse of liquid wastes rather than direct disposal to the environment and the use of evaporator technology to reduce liquid waste volumes for particular waste arisings.
- Efforts to minimise waste arisings by optimised fuel use and endeavours to reduce fuel failure rates, which are argued to be low based on recent operational experience. Particular aspects of relevance include, for example, the proposed use of burnable neutron poisons and measures to avoid, detect and manage any failed fuel that might arise.
- Selection of appropriate solid waste conditioning approaches and the selection of appropriate disposal routes. (Waste conditioning involves transforming radioactive waste into a form suitable for handling, transportation, storage and disposal. Conditioning may include some or all of the following stages: the conversion of the waste to a solid waste form, enclosure of the waste in containers and, if necessary, provision of an overpack).

- Optimised deployment of low cobalt alloys for specific applications such that the activated metal waste arisings due to cobalt-60 are minimised, where practicable.
- Identification of what constitutes BAT for measuring and assessing discharges and disposals from the UK ABWR (see Section 5.3).
- The long-term management of spent nuclear fuel, including any failed fuel, such that future disposal is not compromised. This is of particular interest given that prolonged storage of higher burn up fuels may be necessary to meet future geological disposal waste acceptance criteria.

Hitachi-GE has requested that Radioactive Waste Management Limited (RWM) perform an assessment of the disposability of those higher activity wastes (comprising ILW and spent fuel) with no current disposal route, but assumed to be destined for the national GDF. This disposability assessment, which is currently on-going, will consider the compatibility of such wastes with the proposed GDF. The disposability assessment will use an established process that is based on the approach used in assessing similar wastes for existing nuclear operators. It will be available for the GDA detailed assessment stage.

We note that:

- the solid waste arisings from the UK ABWR do not differ fundamentally from those from existing reactor technologies
- Hitachi-GE are proposing familiar waste conditioning approaches for GDA, which are based on standard container designs and cement encapsulation of ILW arisings

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

For our detailed assessment, we will need further information as set out in Items 5.1 to 5.4 of Annex 2.

## 5.2. Quantification of radioactive waste disposals

We ask the requesting party to provide numerical estimates for:

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

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

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

We also ask the requesting party to provide proposed annual limits (on a rolling twelve-month basis) for gaseous and aqueous discharges, together with 'campaign' limits (for example, to reflect an operating cycle) if it thinks these are appropriate. We expect the proposed limits to be consistent with the appropriate limit setting guidance (Environment Agency, 2012).

### Gaseous and aqueous discharges

Hitachi-GE's submission provides estimates of discharges and proposed limits in 'Quantification of Discharges and Limits' (GA91-9901-0025-00001 revision C). The submission identifies radionuclides which will be discharged from the UK ABWR, and presents estimated annual gaseous and liquid discharges together with proposed annual limits. The majority of radioactivity is discharged as gaseous effluent from the main stack located on the roof of the reactor building. Liquid discharges to the sea form a small proportion of the total expected discharges from the UK ABWR. Three methods have been used to estimate annual discharges: calculation, assumption

and discharge data. The majority of radionuclides have been estimated by calculation or assumption (based on reportable limits under Japanese law); estimates for three radionuclides are based on discharge data.

We have compared estimated annual discharges from the UK ABWR to those of other BWRs in Europe, for gaseous and liquid discharges (see Annex 3). The estimated annual discharges from the UK ABWR are comparable to those of similar European reactors. We will extend this comparison to reactors world-wide in our detailed assessment.

Proposed limits are derived using methods consistent with our limit setting guidance (Environment Agency, 2012). The limits reflect estimated discharges multiplied by 2 to allow for uncertainties associated with building a new design. The submission states that fuel pin failure is the only undesirable event expected to occur during the lifetime of the reactor that will give rise to elevated discharges. Estimated increases in discharges due to fuel pin failure are presented in the submission by Hitachi-GE and are included in the proposed limits. The proposed limits for discharges to air and water are in Tables 3 and 4, respectively. During the detailed assessment, we will further assess the data used to derive the proposed limits and consider what limits we might set in any future permit.

**Table 3 Proposed limits for discharges to air**

| Radionuclide (or group) | Proposed 12 month rolling limit (GBq) |
|---|---|
| **Tritium** | 1600 |
| **Carbon-14** | 1500 |
| **Argon-41** | 1200 |
| **Noble Gases (group including argon-41)** | 26800 |
| **Iodine-131** | 0.79 |
| **Iodines (group including iodine-131)** | 3.95 |
| **Strontium-89 / strontium-90** | 0.008 |
| **Other beta/gamma** | 0.72 |
| **Total alpha** | 0.024 |

**Table 4 Proposed limits for discharge to water**

| Radionuclide (or group) | Proposed 12 month rolling limit (GBq) |
|---|---|
| **Tritium** | 1300 |
| **Carbon-14** | 0.38 |
| **Caesium-137** | 0.013 |
| **Strontium-89 / strontium-90** | 0.0048 |
| **Iodine-131** | 0.0032 |
| **Other beta/gamma** | 3.18 |
| **Total alpha** | 0.228 |

During our initial assessment of the estimated gaseous and liquid discharges, it has become clear that the evidence presented to underpin estimated discharges is not sufficiently robust.

Discharge estimates for radionuclides that are significant in terms of amount discharged or resultant dose, are currently underpinned by one strand of evidence only (calculation, assumed values or actual discharge data). Estimates for three significant radionuclides are based on actual discharge data. However, only one of these (tritium) is based on discharges from operating ABWRs. There are several ABWRs in operation in Japan, and it is not clear why estimated discharge data for more of the radionuclides have not been based on actual discharge data from these power stations. In order to address this, we have issued a RO, jointly with ONR, on source terms during normal operations for the UK ABWR (Regulatory Observation RO-ABWR-0006 – source term). The RO requests the definition and justification of estimated discharges, with multiple strands of robust, appropriate evidence to support the estimates for significant radionuclides. The response to this RO may result in changes to the estimated discharges and proposed limits. For example, it is not clear how much headroom is already included within the estimated discharges and hence the multiplication factor used to derive the proposed limits may need to be altered.

## Other radioactive waste

Hitachi-GE has provided an extensive collection of estimates of other radioactive waste arising during power station operation and decommissioning as well as an estimate of the volume of non-radioactive waste arising from decommissioning in 'Radioactive Waste Management Arrangements' (GA91-9901-0022-0001, revision C).

We are content that these estimates are realistic at this stage, but note that there are some areas within these estimates that are currently unknown or are subject to re-evaluation. For example, the potential for contaminated oils to be produced has been identified. The lack of information regarding contamination status means that we cannot be sure that the proposed incineration route is applicable. For our detailed assessment we will need further information as set out in Items 5.3, 5.4, 6.1 to 6.4, 7.3 and 7.4 of Annex 2 relating to clarification of these items which are unknown or under re-evaluation.

The UK ABWR will use the 'GE 14' fuel design, with each assembly consisting of a fuel bundle (composed of fuel rods, water rods, spacers, and upper and lower tieplates) and a channel that surrounds the fuel bundle. Hitachi-GE has estimated that approximately 9600 spent fuel assemblies will arise during the proposed operational lifetime of the UK ABWR. Average discharged fuel burn-ups of the order 50 GWd/t are anticipated, although maximum burn-ups may exceed this and are yet to be formally communicated. Recently supplied provisional information suggests a batch average burn-up of 52~55 GWd/t and maximum fuel bundle burn-up of 60 GWd/t, with peak pellet burn-ups of the order 68 GWd/t. The disposability of these highly active solid waste arisings is currently being assessed and, for GDA purposes, it is being assumed that waste will be disposed in welded copper canister with ductile cast iron inserts (so called ‘KBS-3’ containers). We will consider the outcomes of the RWM disposability assessment at the detailed assessment stage of GDA.

## Combustible waste

The submission provides estimates of discharges and waste arisings in 'Radioactive Waste Management Arrangements' (GA91-9901-0022-00001, revision C). Some information is presented on possible combustible waste types, but for radioactive combustible waste only. As is appropriate for GDA no specific waste routes have been identified. Quantities of radioactive combustible wastes are unknown and there will be no on-site incinerator. No information is available for non-radioactive combustible wastes.

We had not received any comments on the quantification of radioactive discharges and limit setting by 31 May 2014.

Our conclusions for quantification of radioactive waste disposals, at the principle level, are:

- based on the information we have at present, it is likely that radioactive discharges would not exceed those of comparable power stations
- the proposed discharge limits are appropriate

- that more information is required on the quantities and characteristics of both radioactive and non-radioactive wastes.

More evidence is required to justify and underpin the estimated discharges for the UK ABWR and for our detailed assessment; we will need the further information as set out in Items 4.1 and 6.1 to 6.4 of Annex 2 (including RO-ABWR-0006).

## 5.3. Measurement and assessment of discharges and disposals of radioactive waste

We ask the requesting party to describe the proposed sampling arrangements, techniques and systems for measurement and assessment of discharges and disposals of radioactive waste. This should include information on in-process monitoring arrangements as well as those for final discharges.

Hitachi-GE's submission describes, at a high level, the design principles for the sampling, measurement and monitoring regime that will be included in the UK ABWR design in their document 'Approach to Sampling and Monitoring' (GA91-9901-0029-00001, revision C).

The principles state that data regarding radioactivity, radionuclide composition and volume will be measured to ensure compliance with permit conditions, during both operation and maintenance. However, no details are provided on how this will be implemented. All routes for radioactive discharges to the environment under normal operations, for example, the main stack and main outfall, will be identified and monitored to obtain complete discharge data. Further principles cover the need for:

- continuous monitoring to record temporal fluctuations in discharge levels
- grab sampling and analysis to demonstrate compliance with limits
- analysis of samples from batch discharge points prior to discharge
- provision for continuous monitoring included within the design to prevent human error, which on the Japanese ABWR, takes the form of a radiation monitor on the liquid discharge line and if an anomaly is detected an alarm is activated and closes an isolation valve stopping the discharge to the environment

Design information for a Japanese ABWR has been provided as background information. This indicates monitoring of the main stack discharge for gross radiation levels during normal operation and collection of particulate, halogen and vapour condensed water samples for analysis. A representative sample is continuously abstracted from the main stack through an isokinetic probe. It is then passed through sample panels for monitoring and sampling before being returned to the main stack. Alarms are activated in the control room if an anomaly is detected.

For a Japanese ABWR, liquid waste that has been processed through one or more treatments is discharged from sample tanks. Prior to discharge the tanks are stirred and a sample taken and analysed. Discharge is allowed if the radioactivity levels are below discharge limits. Continuous monitoring of gross radiation level is undertaken in the liquid effluent at the final discharge path during discharge to the environment and discharge is stopped on high radiation level.

For a Japanese ABWR in-process radiation monitoring takes place continuously on the off-gas and turbine gland seal off-gas before they feed in to the main stack. Provision for grab sampling for nuclide analysis is also included. Heating, ventilation and air-conditioning (HVAC) exhaust is not sampled independently before the main stack. Monitoring of the inlet and outlet of the gaseous waste management system is undertaken on a Japanese ABWR. If an anomaly is detected an alarm is activated in the control room.

No details are given for the monitoring of solid wastes, although one of the Hitachi-GE principles states that transfer of on-site stored radioactive wastes (for example, solid wastes) to the proper authorities is allowed once levels have been reviewed and approved as suitable for acceptance.

Hitachi-GE's submission states that an environmental monitoring programme is not included within GDA due to the site-specific nature of the programme that will be developed. Hitachi-GE state that it is committed to making sure that the future site operators will have a well-developed and

meaningful environmental monitoring programme and will work with potential future operators to this effect.

In our view the submission fails to address whether the arrangements:

- include determining discharges of all appropriate radionuclides recommended by the European Union (EU) (EU, 2004)
- are adequate to determine discharges at the levels of detection recommended by the EU (EU, 2004)
- represent the BAT for measuring and assessing discharges and disposals

We had not received any comments on the measurement and assessment of radioactive waste discharges and disposals by 31 May 2014.

Insufficient information has been provided for us to draw any conclusions on whether the proposals for measurement and assessment of discharges and disposals of radioactive waste are acceptable.

For our detailed assessment, we will need further information as set out in Items 7.1 – 7.5 of Annex 2. In support of these we have raised RQs (RQ-ABWR-0105 and RQ-ABWR-0106), specifying our requirements and expectations on the operator's monitoring of discharges and provision for independent monitoring.

## 5.4. Aspects related to other environmental regulations

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

## Water use and abstraction

We ask the requesting party to provide details and estimates of:

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

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

Hitachi-GE's submission describes process and cooling water requirements in Section 4 of the document ‘Other Environmental Regulations’ (GA91-9901-0027-00001 revision C).

Fresh water will be used in the ‘Domestic Water System’ and will also be de-ionised for component cooling and decontamination as part of the ‘Makeup Water Purified System’. It has been stated for GDA that the source of fresh water will be from the local water company; therefore, an abstraction licence will not be required. No information has been supplied at this stage on the fresh water usage rates to enable us to determine whether water usage is sustainable and within the capacity of the local water supplier.

Once-through sea water cooling will be used in the main steam condenser and for cooling of other reactor and turbine components. Cooling water flow is based on 12 °C temperature uplift. A 12 °C uplift is comparable with that of other nuclear reactor designs, but we cannot comment on the potential impact as this will be determined during site-specific assessment.

We had not received any comments on water use and abstraction by 31 May 2014.

Our conclusions, at the principle level, are:

- an abstraction licence would not be required
- insufficient information is provided to determine whether the design of the cooling water abstraction system will adequately protect fish

For our detailed assessment, we will need further information as set out in Items 8.1 – 8.4 of Annex 2.

## Discharges to surface waters

Discharges to surface waters of non-radioactive contaminants will require a permit under EPR10. We ask the requesting party to provide a description of how aqueous waste streams will arise, be managed and be disposed of, throughout the facility's lifecycle. We expect this to include consideration of potential options and associated environmental impact for disposal of each individual effluent stream, including the environmental impact of thermal discharges.

Hitachi-GE's submission describes discharges to surface waters in Section 5 of the document 'Other Environmental Regulations' (GA91-9901-0027-00001 revision C).

At this stage, only very limited information has been supplied, but this identifies a number of important effluent streams. The submission sets out what information will be provided in later submissions and describes how this will be used to meet the requirements of the P&ID (Environment Agency, 2013). Hitachi-GE propose that no thermal dispersion modelling will be carried out during GDA and that the thermal impact of discharges will be assessed at the site-specific permitting stage. We have agreed that this is appropriate.

We had not received any comments on discharges to surface waters by 31 May 2014.

Insufficient information has been provided for us to draw any conclusions on whether the environmental impact of the proposed discharges of non-radioactive species (including heat) to surface waters, at a site within the generic site constraints, will be acceptable.

For our detailed assessment, we will need further information as set out in Items 9.1 – 9.5 of Annex 2.

## Discharges to groundwater

Hitachi-GE's submission confirms in Section of 6 of document 'Other Environmental Regulations' (GA91-9901-0027-00001 revision C) that there are no discharges to groundwater.

## Operation of installations (combustion plant and incinerators)

Most nuclear power station designs include conventional combustion plant for standby generation and / or use as auxiliary boilers. Above a certain capacity, operation of such plant will require an environmental permit and a greenhouse gas emissions permit from the Environment Agency / NRW. Therefore, we ask the requesting party to identify what combustion plant will be provided and:

- if the aggregate rated thermal input of all combustion plant is greater than 50 MW, for a comparison of the proposed technology against our sector guidance (Environment Agency, 2009)
- if the aggregate thermal input is greater than 20 MW, for a description of how greenhouse gas emissions will be monitored

Hitachi-GE's submission describes the combustion plant in Section 7 of the document 'Other Environmental Regulations' (GA91-9901-0027-00001 revision C).

The combustion plant will comprise of:

- two auxiliary boilers, each with a gross rated thermal input of 13.1 MWth
- three back-up generators, each with a gross rated thermal input of 14.6 MWth
- a back-up diesel generator with a gross rated thermal input of 14.6 MWth

Given that the total thermal input of the combustion plant exceeds 50 MW, an environmental permit will be required. A comparison of the proposed technology against our sector guidance has not been included within this submission.

A greenhouse gas emissions permit will also be required as the total thermal input is greater than 20 MW. No specific information has been supplied on how monitoring of greenhouse gas emissions will be carried out.

We had not received any comments on the combustion plant by 31 May 2014.

An EPR10 permit might also be needed for any on-site waste incinerator. However, the submission confirms in Section 7.4 of document 'Other Environmental Regulations' (GA91-9901-0027-00001 revision C) that the design does not include an on-site incinerator.

Our conclusions, at the principle level, are:

- the proposed combustion plant would require a permit from the Environment Agency / NRW under EPR10
- insufficient information has been provided to determine whether the proposed technology is consistent with our sector guidance
- the proposed combustion plant would require a greenhouse gas emissions permit
- insufficient information has been provided to determine whether the proposals for monitoring greenhouse gas emissions are acceptable

For our detailed assessment, we will need further information as set out in Items 11.1 – 11.2 of Annex 2.

## Substances subject to the Control of Major Accident Hazards Regulations

We ask the requesting party to identify any need for the on-site storage of 'dangerous substances' above the qualifying thresholds in Control of Major Accidents Hazards Regulations (1999) (COMAH99) and, if a threshold is exceeded, to describe the measures taken in the design to prevent a major accident to the environment.

The submission discusses dangerous substances in Section 8 of document 'Other Environmental Regulations' (GA91-9901-0027-00001 revision C).

The submission states that "it has been assessed that the Control of Major Accidents Hazards (COMAH) will not apply to the UK ABWR during GDA", however, there is no information provided on the quantities of any dangerous substances that will be stored on site to demonstrate this is the case.

We had not received any comments on substances subject to COMAH99 by 31 May 2014.

Insufficient information has been provided for us to draw any conclusions on whether COMAH99 applies.

For our detailed assessment, we will need further information as set out in Item 12.1 of Annex 2.

# 6. Overall conclusions of our initial assessment

In this initial assessment we examined the management systems used for producing the submission and the impact of the proposed radioactive discharges. We formed a view as to whether the submission contained any matters that are obviously unacceptable or whether we could identify any significant design modifications that are likely to be required. We also assessed whether there was sufficient information to undertake the detailed assessment stage.

The overall conclusions of our initial assessment for the UK ABWR nuclear power station design are:

- The submission does not adequately address all of our information requirements (as set out in our process and information document (P&ID) (Environment Agency, 2013)). Hitachi-GE has committed to providing the required information on a timescale that, subject to the information being of adequate quality, should enable us to maintain our indicative target of four years for completing a meaningful GDA.
- We have not at this stage identified any matters addressed by the submission that are obviously unacceptable.
- We have not at this stage identified any significant design modifications that are likely to be required.
- Hitachi-GE has an appropriate management system in place to control the content and accuracy of the information it provides for GDA.
- The annual radiation impact of the UK ABWR design on people would be below the UK constraint for any single new source.
- Based on the information we have at present, it is likely that radioactive discharges would not exceed those of comparable power stations.
- The generic site description is broadly consistent with the potentially suitable coastal sites identified in the nuclear national policy statement (UK Parliament, 2011a).

These conclusions are based on our initial assessment. Further or modified conclusions may be developed once Hitachi-GE has provided all the required information and we have carried out our detailed assessment.

We will only proceed to detailed assessment of the UK ABWR and subsequent consultation once we are satisfied that the regulators and Hitachi-GE are ready to do so.

## Further information requirements

Our information requirements are set out in our P&ID (Environment Agency, 2013). The submission does not fully address a number of these requirements and further information is required to enable us to carry out our detailed assessment. Hitachi-GE has committed to provide each item of information specified in Annex 2. Subject to the quality of the information provided, the proposed timetable will allow us to proceed to consultation in March 2016 (date may be subject to change). This is consistent with achieving the four year timeframe (from receipt of initial submission) for completion of GDA.

# References


| Reference | Author / Publication / Website |
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# List of abbreviations

| Acronym | Definition |
|---|---|
| ABWR | Advanced Boiling Water Reactor |
| BAT | Best Available Techniques |
| BWR | Boiling Water Reactor |
| COMAH | Control of Major Accident Hazards |
| COMAH99 | The Control of Major Accident Hazards Regulations 1999 |
| DRP | Design Reference Point |
| EA95 | The Environment Act 1995 |
| EPR10 | Environmental Permitting (England and Wales) Regulations 2010 (as amended) |
| EU | European Union |
| GBq | Gigabecquerel |
| GDA | Generic Design Assessment |
| GDF | Geological Disposal Facility |
| GWd/t | Gigawatt Days per Tonne of Uranium |
| Gy | Gray (SI measurement unit of absorbed dose) |
| HCW | High Conductivity Waste |
| HEPA | High Efficiency Particulate Air (filter) |
| HVAC | Heating, Ventilation and Air-Conditioning |
| ILW | Intermediate Level Waste |
| IAEA | International Atomic Energy Agency |
| ISFS | Interim Spent Fuel Storage |
| iSoDA | Interim Statement of Design Acceptability |

| | |
|---|---|
| JPO | Joint Programme Office |
| KBS-3 | Kärnbränslesäkerhet-3 (A Swedish waste container type) |
| LCLC | Local Community Liaison *Co*uncil |
| LCW | Low Conductivity Waste |
| LLW | Low Level Waste |
| LLWR | Low Level Waste Repository |
| MDSL | Master Document Submission List |
| MW | Megawatts (SI measurement unit of power) |
| MWe | Megawatt-electrical (SI measurement unit of electrical power) |
| MWth | Megawatt-thermal (SI measurement unit of thermal power) |
| NRW | Natural Resources Wales |
| OG | Off-gas system |
| ONR | Office for Nuclear Regulation |
| P&ID | Process and Information Document |
| PRIS | Power Reactor Information System |
| QMS | Quality Management System |
| REPs | Radioactive Substances Regulation Environmental Principles |
| RI | Regulatory Issue |
| RO | Regulatory Observation |
| RQ | Regulatory Query |
| RSMDP1 | Radioactive Substances Regulation Environmental Principle (REP) concerned with Radioactive Substance Management (including Waste Disposal) |
| RWA | Radioactive Waste Adviser |
| RWM | Radioactive Waste Management (Ltd) |

| | |
|---|---|
| RWMA | Radioactive Waste Management Arrangements |
| SoDA | Statement of Design Acceptability |
| SQEP | Suitably Qualified and Experienced Personnel |
| SSG | Site Stakeholder Group |
| Sv | Sievert (SI measurement unit of dose) |
| UK | United Kingdom |
| USA | United States of America |
| WRA91 | The Water Resources Act 1991 |

# Annex 1- Documents included in Hitachi-GE's submission

| Report No. GA91-9901- | Rev. | Title |
|---|---|---|
| **0017-00001** | B | Definition of design reference point |
| **0018-00001** | B | GDA PCSR development strategy |
| **0019-00001** | C | Summary of generic environmental permit applications |
| **0020-00001** | C | Generic site description |
| **0021-00001** | C | Approach to optimisation |
| **0022-00001** | C | Radioactive waste management arrangements |
| **0023-00001** | C | Demonstration of BAT |
| **0025-00001** | C | Quantification of discharges and limits |
| **0026-00001** | C | Prospective dose modelling |
| **0027-00001** | C | Other environmental regulations |
| **0028-00001** | C | Consideration of and compliance with the Radioactive Substance Regulation Environmental Principles |
| **0029-00001** | C | Approach to sampling and monitoring |
| **0033-00001** | A | Hitachi-GE UK ABWR concept design |
| **0034-00001** | A | Genesis of ABWR design |
| **0035-00001** | A | Resilience of design against Fukushima type events |
| **0041-00001** | B | Preliminary Safety Report on reactor chemistry |
| **0042-00001** | B | Preliminary Safety Report on radioactive waste management system |
| **0043-00001** | A | Preliminary Safety Report on decommissioning |
| **0045-00001** | A | Preliminary Safety Report on spent fuel interim storage |
| **0046-00001** | B | Preliminary Safety Report on reactor core and fuels |

The total list of documents that Hitachi-GE has submitted to the regulators is listed in the Master Document Submission List (MDSL). Hitachi-GE has published the documents listed in the table above on its website: http://www.hitachi-hgne-uk-abwr.co.uk/gda_library.html

# Annex 2 - Further information required for detailed assessment

| Information required | Provision date |
|---|---|
| Management system<br>1.1 Further evidence required that consideration of BAT in the design control process would be adequately recorded. | August 2015 |
| Generic site and dose assessment<br>2.1 The parameters set out in the Generic Site Description are limited to those characteristics used in assessments undertaken to date. These will be expanded to include additional parameters should this be required for assessments later in GDA.<br>2.2 More information is required on sources of direct radiation to the public.<br>2.3 The dose assessment requires updating in response to any changes to the source term for discharges and sources of direct radiation. | Prior to August 2015<br>December 2014<br>August 2015 |
| Radioactive waste management – strategic considerations<br>3.1 The RWMAs, as they are presented, do not describe or address any issues associated with liquid or gaseous effluents.<br>3.2 Information required on how each individual REP will be met required for detailed assessment. | August 2015 |
| Radioactive waste arisings & proposals for management and disposal<br>4.1 Improved information required on proposed waste arisings. | August 2015 |
| Protection of people and the environment (BAT)<br>5.1 Further evidence is required to support the BAT claims and arguments.<br>5.2 Radionuclide specific BAT cases to demonstrate how BAT will apply to key, individual radionuclides that will arise in UK ABWR wastes.<br>5.3 Disposability assessments for those wastes with no existing disposal routes and evidence that any findings will be suitably addressed in GDA, where possible.<br>5.4 RQ-ABWR-0091 Implications of failed fuel for the disposal inventory. | August 2015 |
| Quantification of radioactive waste disposals<br>6.1 Appropriate, robust evidence is required to support the estimates of gaseous and liquid discharges (as detailed in the regulatory observation RO-ABWR-0006). This evidence is to include performance data from similar facilities (as requested in the P&ID).<br>6.2 Details on the contribution that each constituent of normal operations (such as maintenance and testing) makes to discharges.<br>6.3 Demonstration that expected discharges will not exceed those of comparable power stations across the world.<br>6.4 Further information on the assessment of expected events under normal operations. | December 2014 for topic reports; August 2015 for update of submission<br>December 2014<br>December 2014<br>December 2014 |

| | |
|---|---|
| Measurement and assessment of radioactive waste discharges and disposals<br>7.1 Details of in-process monitoring arrangements.<br>7.2 Details of monitoring arrangements for final discharges of gaseous and aqueous wastes.<br>7.3 Details of monitoring arrangements for disposals of non-aqueous liquid and solid wastes.<br>7.4 A demonstration that the proposals represent BAT for monitoring.<br>7.5 Confirmation that sensitivity is sufficient to:<br>• readily demonstrate compliance with the proposed limits<br>• meet the levels of detection specified in EU Commission Recommendation 2004/2/Euratom<br>The above are covered by the following RQs:<br>• RQ-ABWR-0106 Operator Monitoring of Discharges.<br>• RQ-ABWR-0105 Independent Monitoring. . | August 2015 |
| Water use and abstraction<br>8.1 Provide details and estimates of the fresh water requirements for the design.<br>8.2 Provide details and estimates of cooling water requirements for the design relevant to the generic site.<br>8.3 Provide information on potential cooling water options including consideration of conventional cooling towers or hybrid cooling towers.<br>8.4 Provide information on options for design of abstraction inlet fish deterrent schemes and return schemes. | August 2015 |
| Discharges to surface waters<br>9.1 Identify individual effluent streams and surface water streams contributing the overall discharge and describe how they are controlled.<br>9.2 Provide information on sources and quantities of contaminants (including disinfectants and biocides) and highlight any priority substances (as specified in the “Priority Substances” Directive 2008).<br>9.3 Provide information on potential options and associated environmental impact for disposal of each individual effluent stream.<br>9.4 Provide details on the means of control in the event of detection of unplanned radioactive or other contamination of the discharge.<br>9.5 Provide options for beneficial use of the waste heat produced. | August 2015 |
| Installations (combustion plant)<br>11.1 For the combustion plant (auxiliary boilers and back-up generators) provide a comparison of the proposed technology against the sector guidance.<br>11.2 Describe how greenhouse gas emissions will be monitored. | August 2015 |
| COMAH substances<br>12.1 Provide details on the maximum quantities of any dangerous substances that will be stored on site and provide a comparison against the COMAH qualifying levels. | August 2015 |

# Annex 3 - Comparison of gaseous and aqueous discharges with those of other European BWRs

**Table A3-1 Average annual gaseous discharges from European BWRs (2004 - 2008) and estimated discharges from the UK ABWR, normalised to 1000 MWe in Gigabecquerels (GBq). (Reported to two significant figures)**

| Reactor | Tritium | Noble gases | Iodine-131 | Carbon-14 | Other Beta/Gamma |
|---|---|---|---|---|---|
| **Olkiluoto 1 & 2** | 200 | 2000 | 0.03 | 480 | 0.015 |
| **Brunsbuttel** | 110 | 3200 | 0.01 | 310 | 0.069 |
| **Gundremmingen B & C** | 370 | 950 | 0.00 | 270 | 0.0003 |
| **Isar 1** | 140 | 2900 | 0.04 | 380 | No data |
| **Krummel** | 24 | 1800 | 0.05 | 160 | 0.0070 |
| **Philippsburg 1** | 37 | 2200 | 0.08 | 400 | 0.030 |
| **Cofrentes** | 1200 | 28000 | 1.01 | 420 | 0.76 |
| **Sta Maria de Garona** | 1800 | 26000 | 0.22 | 500 | 1.1 |
| **Forsmark 1,2 & 3** | 310 | 2300 | 0.02 | 750 | 0.043 |
| **Oskarshamn 1,2 & 3** | 370 | 17000 | 0.14 | 280 | 2.3 |
| **Ringhals 1** | 230 | 9800 | 0.04 | 580 | 0.097 |
| **UK ABWR** | 590 | 3700 | 0.13 | 540 | 1.0* |

*includes strontium-89, stontium-90, and iodines other than iodine-131.

**Table A3-2 Average annual liquid discharges from European BWRs (2004 - 2008) and estimated discharges from the UK ABWR, normalised to 1000MWe (GBq). (Reported to two significant figures)**

| Reactor | Tritium | Other Beta/Gamma |
|---|---|---|
| **Olkiluoto 1 & 2** | 1200 | 0.31 |
| **Brunsbuttel** | 370 | 0.34 |
| **Gundremmingen B & C** | 2000 | 0.45 |
| **Isar 1** | 490 | 0.068 |
| **Krummel** | 350 | 0.0057 |
| **Philippsburg 1** | 460 | 0.19 |
| **Cofrentes** | 470 | 0.075 |
| **Sta Maria de Garona** | 890 | 0.75 |
| **Forsmark 1,2 & 3** | 770 | 0.24 |
| **Oskarshamn 1,2 & 3** | 450 | 1.3 |
| **Ringhals 1** | 1000 | 6.3 |
| **UK ABWR** | 470 | 1.3* |

*Includes all beta/gamma emitters other than tritium.

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