Cyfoeth Naturiol Cymru
Natural Resources Wales

Environment Agency

Assessing new nuclear power station designs

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

Assessment report - AR11 Other Environmental Regulations

December 2017

The Environment Agency protects and improves the environment.

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

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

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

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

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

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

Published by:

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

Natural Resources Wales
Cambria House
29 Newport Road
Cardiff, CF24 0TP
Email: enquiries@naturalresourceswales.gov.uk

Further copies of this report are available from our publications catalogue:
www.gov.uk/government/publications

or our National Customer Contact Centre:
T: 03708 506506

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

or
Natural Resources Wales: 0300 065 3000
Email: enquiries@naturalresourceswales.gov.uk

Executive summary

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

Process and Information Document[1]	The following sections of Table 1 in our process and information document (P&ID) are relevant to this assessment: Section 8: Information relating to other environmental regulations to include: • water use and abstraction • discharges to surface waters • discharges to groundwater • operation of installations (combustion plant and incinerators) • substances subject to the Control of Major Accident Hazards (COMAH) Regulations

Report author	Mike Baggs

In the generic design assessment (GDA) process most of the regulatory effort is focused on matters relating to arisings and disposals of radioactive waste and its impact on the environment. There are number of other environmental regulations that may also apply to the operation of a nuclear power plant where the Environment Agency and Natural Resources Wales have a regulatory role. These are:

- water use and abstraction – nuclear power plants require significant volumes of water for use in the process and for cooling and an abstraction licence may be required
- discharges to surface waters – nuclear power plants produce non-radioactive aqueous waste streams which require an environmental permit to discharge to surface water
- discharges to groundwater – any potential discharges to groundwater need an environmental permit
- operation of installations – nuclear power plants require back-up power in the case of loss of on-site power and also additional steam supplies for start-up, operation and reactor shutdown. The combustion plant (for example, diesel generators or boilers) used will need an environmental permit. Depending upon the size of the combustion plant it may also need a greenhouse gas permit

---

[1] Process and information document for generic assessment of candidate nuclear power plant designs, Version 2, Environment Agency, March 2013. http://webarchive.nationalarchives.gov.uk/20151009003754/https://www.gov.uk/government/publications/assessment-of-candidate-nuclear-power-plant-designs
Latest version is Process and information document for generic assessment of candidate nuclear power plant designs, Version 3, Environment Agency, October 2016. https://www.gov.uk/government/publications/assessment-of-candidate-nuclear-power-plant-designs. Note - no material changes between revisions.

Any incineration of waste on site will also need an environmental permit

- COMAH Regulations – nuclear power plants typically use dangerous substances, such as diesel oil in the combustion plant or hydrazine as an oxygen scavenger, and may be subject to COMAH depending on the amount of dangerous substances stored on site

Hitachi-GE presented information covering these areas in its 'Other Environmental Regulations' submission in accordance with the requirements in Section 8 of Table 1 of the P&ID (Environment Agency 2013a).

There are certain aspects of the UK ABWR cooling water design that can only be finalised at the site-specific stage and this includes the abstraction intakes and fish deterrent and return schemes.

It has been agreed that thermal modelling will be out of scope of GDA as this requires information of the behaviour of the receiving surface water.

We have assessed Hitachi-GE's 'Other Environmental Regulations' submission up to and including information submitted on 31 August 2017. We conclude that for the UK ABWR design:

- an abstraction licence is not likely to be required, as the cooling water is taken directly from the open sea and the fresh water is supplied directly by the local water company
- the discharge of non-radioactive aqueous waste will require an environmental permit. A water discharge permit could be granted, however, any future operator will need to provide more detailed information on the aqueous waste streams and demonstrate that the environmental impact from the discharges is likely to be acceptable at the site-specific permitting stage
- there are no direct or indirect discharges to groundwater based on the generic design of the site, therefore, an environmental permit is not required. The pollution prevention techniques specified in the design should prevent contamination of groundwater
- the combustion plant to be used (auxiliary boilers and diesel generators) will require an environmental permit. Based on the information provided it is likely that a permit could be granted as part of the site-specific permitting process. The operator will need to provide a best available techniques (BAT) assessment for the specific design of the boilers and generators to be chosen, demonstrate that the combustion plant would comply with emission limit values for certain substances and that impact on people and the environment from the emissions is likely to be acceptable
- the UK ABWR will be an upper tier establishment under COMAH during decommissioning, when higher holdings of hydrazine are stored and used on site, based on the storage of more than 2 tonnes of hydrazine and the assumption, under worse case, that the hydrazine concentration is more than 5% by weight

It should be noted that although in GDA the UK ABWR will not be a COMAH establishment during the operational phase, this is based on a single reactor unit being in the GDA process. It is expected that most operational sites will have at least 2 reactor units and this is likely to mean they will be classed as lower tier establishments during operations due to the quantity of diesel oil being stored.

We have raised 2 Assessment Findings in relation to the other environmental regulations.

Assessment Finding 16: A future operator shall appropriately characterise all aqueous waste streams in its water discharge activity permit application. This shall include identification of all significant contaminants (including biocides, detergents and metals), the concentrations and the volumes being discharged to the environment.

Assessment Finding 17: A future operator shall specify the minimum performance parameters of the combustion plant in its application for a combustion activity permit.

Contents

1. Introduction

Our GDA process focuses primarily on matters relevant to the disposal of radioactive waste. This is for 2 reasons:

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

There are a number of other environmental regulations that may apply to a nuclear power plant. The GDA process needs to ensure that the requirements of these regulations are taken into consideration when assessing the reactor design.

The following topic areas are covered within Hitachi-GE's 'Other Environmental Regulations' submission:

- water use and abstraction
- surface water discharges
- groundwater discharges
- operation of installations (combustion and incineration)
- COMAH Regulations

Our P&ID, (Environment Agency, 2013a) sets out the information we require on other environmental regulations as follows.

Water use and abstraction

Provide details and estimates of fresh water requirements for the design.

Provide details and estimates of cooling water requirements for the design relevant to the generic site. Include consideration of:

- seawater or river water abstraction
- use of conventional cooling towers or hybrid cooling towers
- abstraction inlet fish deterrent schemes
- fish return schemes

Discharges to surface water

Provide a description of how aqueous waste streams will arise, be managed and disposed of throughout the facility's lifecycle. Include:

- sources and quantities of contaminants (including disinfectants and biocides), highlighting any priority substances (as specified in the Priority Substances Directive (EU, 2008))
- identification of the effluent and surface water run-off streams contributing to the overall discharge and how they are treated
- potential options and associated environmental impact for disposal of each individual effluent stream
- the means of control in the event of detection of unplanned radioactive or other contamination of the discharge

- options for beneficial use of the waste heat produced
- environmental impact of thermal discharges

Discharges to groundwater

If there will be discharges to groundwater, describe the nature and quantity of these discharges and provide an assessment of the impact on groundwater.

Operation of installations (combustion plant and incinerators)

Identify what combustion plant, for example standby generation or auxiliary boilers, will be provided.

If the aggregated rated thermal input of all combustion plant is greater than 50 MW, provide a comparison of the proposed technology against our sector guidance.

If the aggregated rated thermal input of all combustion plant is greater than 20 MW, described how greenhouse gas emissions will be monitored.

If the design includes an on-site incinerator with a capacity of 1 tonne or more per hour, provide a comparison of the proposed technology against our sector guidance.

Substances subject to the Control of Major Accident Hazards Regulations

Identify any need for on-site storage of substances above the qualifying thresholds in COMAH99.

If a threshold is exceeded, describe the measures taken in the design to prevent a major accident to the environment.

[Note: COMAH99 (GB Parliament, 1999) has been superseded by COMAH2015 (GB Parliament, 2015) part way through the GDA process for the UK ABWR. The main change is the way in which dangerous substances are classified with the introduction of a new classification system. The fundamental principles of the COMAH regime remain the same and the new regulations have not affected any of the P&ID requirements.]

Regulatory Observations and Regulatory Queries

We have raised 2 Regulatory Observations (ROs) during the detailed assessment.

RO-ABWR-0070 was raised relating to the provision of further information on the levels of contaminants in various aqueous waste streams and the assessment of their impact on the environment. Further detail is included in 'Discharges to water' in the 'Assessment' section below.

RO-ABWR-0060 was raised relating to the environmental impact of the emissions to air from the emergency diesel generators. Further detail is included in 'Operation of combustion plant' in the 'Assessment' section below.

One Regulatory Query (RQ) (RQ-ABWR-0855) was raised requiring further information about volumes, treatment and disposal of the special liquid waste.

2. Assessment

This assessment covers Hitachi-GE's 'Other Environmental Regulations' submission. This submission covered a number of different topic areas that are relevant to the operation of the UK ABWR.

Our approach to the assessment was to:

- consider the generic environmental permit (GEP) submissions made by Hitachi-GE, in particular the other environmental regulations document
- hold technical meetings with Hitachi-GE to clarify our understanding of the information presented and explain any concerns we had with that information
- raise Regulatory Issues (RIs), Regulatory Observations (ROs) or Regulatory Queries (RQs) where we believed Hitachi-GE did not provide sufficient information
- decide on any GDA Issues or other Assessment Findings to carry forward from GDA

2.1. Hitachi-GE documentation

We reviewed the following documents submitted or supplied by Hitachi-GE during our detailed assessment (Table 1):

Table 1. Hitachi-GE documentation reviewed for this assessment

Document No	Title
GA91-9901-0027-0001_Rev F (XE-GD-0098)	Hitachi-GE Nuclear Energy 'Other Environmental Regulations'.
GA91-9901-0027-0001_Rev G (XE-GD-0098)	Hitachi-GE Nuclear Energy 'Other Environmental Regulations'.

3. Water use and abstraction

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

3.1. Assessment objectives

Our assessment for this area was aimed at:

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

3.2. Hitachi-GE documentation

Hitachi-GE has provided the information required by the P&ID in Section 4 of the 'Other Environmental Regulations' document (Hitachi-GE, 2017). This was split into 5 parts.

- P&ID requirement (Section 4.1)
- Regulatory context (Section 4.2)
- Freshwater requirements (Section 4.3)
- Cooling water system requirements (Section 4.4)
- Fish deterrent and fish return systems (Section 4.5)

3.3. Assessment

3.3.1. Freshwater requirements

Hitachi-GE states that the GDA is based on the assumption that all freshwater requirements will be supplied by the local water company. This means that there will be no freshwater abstraction and an abstraction licence is not required.

Provision of freshwater and how it can be sustainably sourced can only be determined when a specific site has been identified and is, therefore, outside the scope of GDA.

Hitachi-GE states that freshwater will be used for the following purposes:

- for drinking, washing and showering
- for use within the process
- to supply the demineraliser plant
- for fire-fighting purposes

Hitachi-GE states that freshwater requirements for domestic use will depend on the number of workers present and will be determined at the site-specific stage.

Hitachi-GE has identified the main processes requiring freshwater and provided the volumes expected to be used during normal operation, shutdown, outage and in emergencies. The freshwater requirement in normal operation is 99.2 m^3/day, which rises to 819.2 m^3/day when the intermittent systems are operating. In outage, the freshwater consumption is expected to be 252 m^3/day, increasing to a maximum of 1,083 m^3/day.

Freshwater is also required by the purified water treatment facility (PWTF). This is used for reactor water, auxiliary boiler water and boronated water in the standby liquid control system. The PWTF is expected to use 900 m^3/day when operating at a maximum rate.

The UK ABWR will have a back-up water supply of 10,000 m^3 comprising of 10 water storage tanks with a storage capacity 1,000 m^3. The water in these tanks is expected to be stored for 15 years.

Fire-fighting requirements are 1,000 m^3 of water.

We have estimated the freshwater usage to be in the region of 370,000 m^3/year based on 11 months of normal operation and 1 month of outage. This does not take into account the intermittent systems operating as there is no frequency defined for these systems. Assuming the intermittent systems operate for a maximum of one month per year the water usage increases to around 430,000 m^3/year.

The freshwater usage is comparable with other reactor designs that have been subject to the GDA process.

3.3.2. Cooling water requirements

Hitachi-GE states that for GDA the generic site is coastal and once-through sea water cooling systems will be used.

There is no requirement for an abstraction licence as we do not licence abstractions from the sea.

Hitachi-GE also states that in general once-through cooling water systems are considered as BAT for coastal locations as identified in the European Commission Best Available Techniques Reference (BREF) Document on Industrial Cooling Systems (EU, 2001).

We commissioned a report entitled 'Cooling water options for the new generation of nuclear power stations' (Environment Agency, 2010). The purpose of the document was to 'investigate the potential cooling water options for new reactors and evaluate the environmental impact of these in terms of thermal, chemical and radionuclide pollution, and impact on biota' to assist the UK regulatory authorities (the Environment Agency, Natural Resources Wales and ONR) in the GDA process. In relation to cooling, the report concludes that direct (once-through) cooling 'can be the most appropriate environmental option for large power stations sited on the coast or estuaries, subject to current best planning, design and operational practice and best available mitigations being put in place, and meeting conservation objectives of the site in question'.

Based on the conclusions from the BREF document and our cooling water options report, we accept, for the purposes of GDA, that once-through cooling water is considered suitable for the UK ABWR design.

The once-through cooling system will be used in the main steam condenser and for cooling other reactor and turbine components. Hitachi-GE states cooling water flow rate is based on a 12^{o}C increase in the intake water temperature at the point of discharge back into the sea. This temperature increase is similar to other reactor designs that have been subject to the GDA process and with existing operational nuclear power plants in the UK.

The seawater cooling system for the UK ABWR is comprised of 3 systems – the circulating water (CW), the turbine building service water (TSW) and the reactor building service water (RSW). The CW system supplies cooling water to the main condenser. The TSW and RSW systems provide seawater to cool and remove heat from the closed loop cooling water systems for the turbine and reactor buildings respectively.

Hitachi-GE has provided the following information on cooling water usage during normal operation and outage (Table 2). These levels are comparable to other reactor designs that have been subject to the GDA process.

Table 2. Hitachi-GE information on cooling water usage during normal operation

Cooling water system	Volume of seawater discharged*	
	Normal operation	Lowest during outage
Circulating water (CW)	184,800 m^3/h	0 m^3/h
Turbine building service water (TSW)	7,400 m^3/h	3,700 m^3/h
Reactor building service water (RSW)	10,800 m^3/h	5,400 m^3/h
Total	203,000 m^3/h	9,100 m^3/h

* As the system uses once-through cooling, the volume discharged indicates the volume that will be abstracted and used in the process.

Hitachi-GE states that seawater inlet and outlet systems need to be sited and designed to reduce the potential for sediment mobilisation and scour on the sea bed and minimise the impact on surrounding habitats and species. Hitachi-GE also states that these factors are site-specific issues and can only be addressed at site-specific permitting. We agree with this comment.

3.3.3. Fish deterrent and fish return schemes

Hitachi-GE states that the seawater intake will be screened to prevent debris as part of the design. Screening prevents fish and other marine organisms from becoming entrained in the cooling water system and blocking condenser tubes, as well as protecting the fish and marine organisms.

Using screens on abstraction inlet and discharge systems can cause damage to fish and other invertebrates through entrapment and impingement, therefore, fish deterrent and return systems are required.

Hitachi-GE states that fish entrapment and impingement is a highly complex matter and depends on a number of factors such as the chemical and physical nature of the water body, the intake requirements of the facility, climatic conditions and the biology of the area.

Hitachi-GE states that although the final design of fish deterrent/protection systems can only be determined at the site-specific stage, a number of options can be considered and taken forward to the site-specific options assessment. Measures to be considered are:

- design of inlet structure to minimise intake velocities
- location of the inlet structure
- use of screens and fish return systems
- physical barriers
- behavioural barriers

Hitachi-GE has provided general information on the use of different screen types available (drum, travelling band, bar) along with other barriers available (physical and behavioural) to prevent fish entrapment and impingement.

We accept that the final design of the sea water abstraction system and fish deterrent and return systems for the UK ABWR can only be completed at the site-specific permitting stage once the local environmental conditions are known.

3.3.4. Eels regulations

Operators abstracting more than 20 m^3/day or discharging water back to any channel sea or bed are subject to the requirements of The Eels (England and Wales) Regulations 2009 (GB Parliament, 2009) and must screen the abstraction/discharge to prevent the entrapment of eels unless an exemption notice has been granted. They may also be required to install by-wash channels alongside screens.

Hitachi-GE states that the measures implemented to reduce fish entrainment and impingement as part of the design of the abstraction will be compliant with the Eels Regulations.

We accept that for the purposes of the GDA that Hitachi-GE has provided sufficient information on abstraction systems and fish deterrent and return systems.

3.4. Conclusions

Following the assessment of water use and abstraction we conclude that:

- an abstraction licence is not likely to be required for the UK ABWR as the cooling water is taken directly from the open sea and the fresh water is supplied directly by the local water company
- the choice of once-through seawater cooling is considered appropriate for the UK ABWR
- the final design of the abstraction intake and fish deterrent and return systems for the UK ABWR to minimise fish ingress and injury and meet the requirements of the Eels (England and Wales) Regulations 2009 (GB Parliament, 2009) is a site-specific issue and can only be determined once the local environmental conditions are known

4. Discharges to surface water

Discharges to waters are controlled by The Environmental Permitting (England and Wales) Regulations 2016 (GB Parliament, 2016). An environmental permit is required for the discharge of any non-radioactive effluent[2] to inland or coastal waters. Further information can be found at www.gov.uk/guidance/discharges-to-surface-water-and-groundwater-environmental-permits.

4.1. Assessment objectives

Our assessment in this topic area was aimed at:

- understanding the different effluent streams produced by the UK ABWR and the non-radioactive contaminants present
- understanding how each effluent stream produced by the UK ABWR is treated and disposed of
- deciding if we could grant an environmental permit for discharge to water from the UK ABWR at the site-specific stage based on the information provided for GDA

4.2. Hitachi-GE documentation

Hitachi-GE provided the information required by the P&ID in Section 5 of the 'Other Environmental Regulations' document (Hitachi-GE, 2017). This was split into 5 parts.

- P&ID requirement (Section 5.1)
- Regulatory context (Section 5.2)
- Effluent characterisation (Section 5.3)
- Effluent treatment and assessment of the impacts of discharged effluents (Section 5.4)
- Identification of options for the beneficial use of waste heat produced (Section 5.5)

4.3. Assessment

4.3.1. Effluent characterisation

Hitachi-GE states that the aqueous streams that could be generated at the UK ABWR site are divided into the following categories:

- discharges from the cooling water systems
- discharges from the drainage networks from non-radioactive areas
- discharges from the drainage networks in the radioactive areas via the liquid waste management system
- effluent from the boiler blow-down and purified water treatment facility (PWTF)
- rainwater

Cooling water systems

[2] Radioactive effluent is permitted separately under the same regulations.

This is the once-through sea water cooling from the CW, TSW and RSW (see ‘Water use and abstraction’ section above). The only contaminants present will be scale washings from the condenser tubes, biocides used to manage bio-fouling, and potentially iron for corrosion control.

Hitachi-GE initially stated that chemical biocides had not been determined for GDA and will be decided at the site-specific stage as they require consideration of the receiving environment.

While we accept that the final choice of biocide is a site-specific matter we expect Hitachi-GE to provide information on the biocides compatible with the UK ABWR design. We raised a Regulatory Observation (RO-ABWR-0070) to request further information on the likely biocides to be used and their typical dosing levels.

In response to RO-ABWR-0070, Hitachi-GE states that sodium hypochlorite is a candidate biocide for use with the UK ABWR. We accept that using chlorine based biocides is typical for power stations that use once-through sea water cooling.

Hitachi-GE states that the dosing strategy for sodium hypochlorite will be designed to ensure that the level of chlorine as total residual oxidant (TRO) discharged to the sea does not exceed the environmental quality standard (EQS) of 0.01 mg/l at the edge of the mixing zone. The concentration of TRO at the discharge outfall is expected to be 0.1 mg/l (see comments in the ‘Environmental impact’ section of this report).

Hitachi-GE states that the exact biocide dosing strategy can only be decided at the site-specific stage as it is dependent on a number of site-specific factors. We agree with this comment.

Hitachi-GE states iron may be used as a corrosion inhibitor in the heat exchangers used in the RSW and TSW systems with expected dosing levels of 0.03 ppm during commissioning and 0.01 ppm in normal operation. It will only be needed for shell and tube heat exchangers and not plate heat exchangers. The final decision on the heat exchanger type will be decided at the site-specific stage.

Drainage networks

The drainage networks within the UK ABWR are categorised according to where the aqueous waste is generated and the presence (and level) of radioactivity, seawater, detergents and chemical impurities.

The drainage networks consist of the following aqueous waste streams:

- service water storm drain (SWSD)
- non-radioactive storm drain (NSD)
- controlled area drain (CAD)
- high chemical impurities waste (HCW)
- low chemical impurities waste (LCW)
- laundry drain (LD) which includes the hot shower drain (HSD)
- boiler blow-down
- effluent from the PWTF
- site drainage (rainwater)

The NSD and SWSD capture aqueous waste from non-controlled areas and Hitachi-GE states that there should be no radioactive contamination in these waste streams.

The CAD, HCW, LCW and LD capture aqueous waste from controlled areas on site and Hitachi-GE states that they may have radioactive contamination. These drainage systems make up the liquid waste management system (LWMS).

Figure 1 below shows how the drainage networks are linked together.

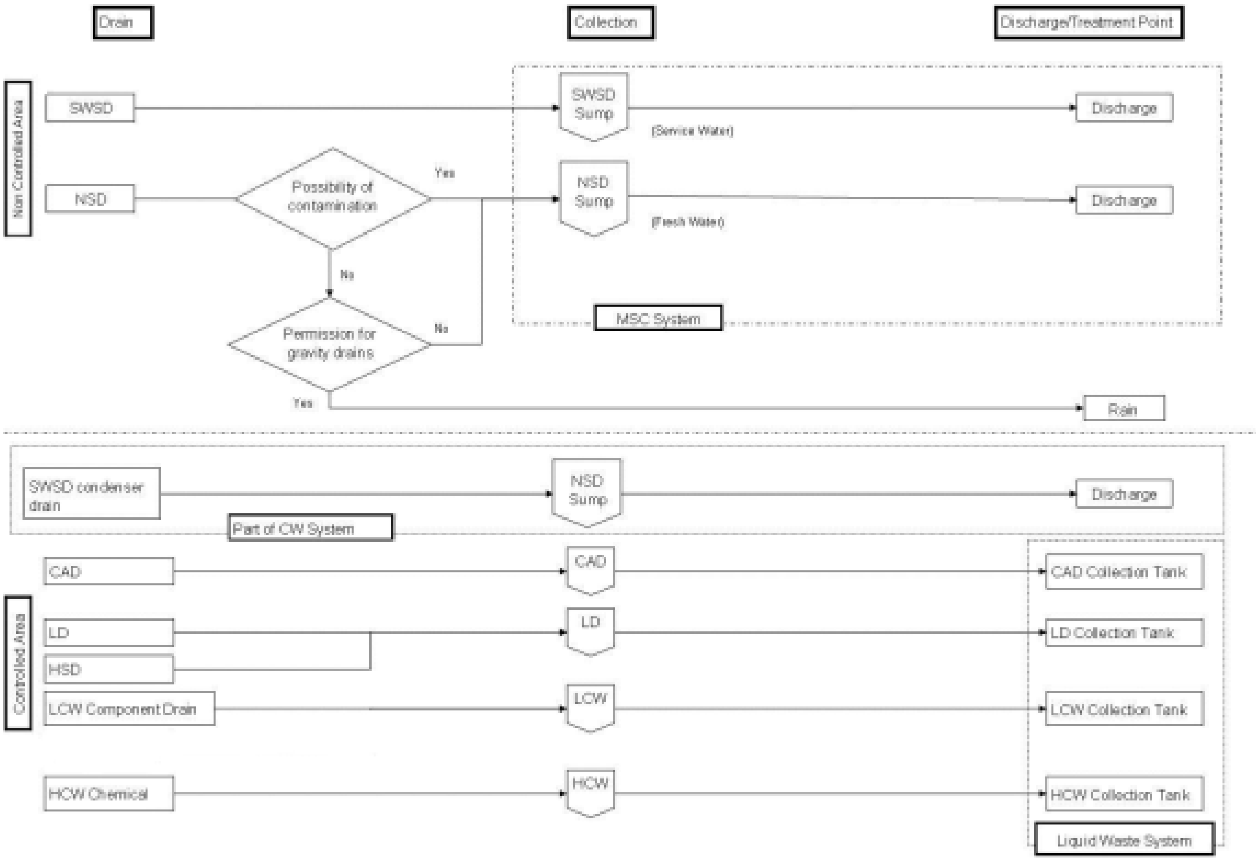

Figure 1. Diagram of the liquid waste management system for the UK ABWR

Non-radioactive drainage networks

Service water storm drain (SWSD)

The SWSD receives service water (sea water) from the heat exchangers and pumps in the RSW and TSW systems during maintenance, or from leakage in the RSW and TSW systems.

The SWSD discharges to the SWSD sump from where it is pumped to sea via the seal pit. The discharge rate from the SWSD is determined by the capacity of the SWSD pump. Discharges from the SWSD are not constant. Hitachi-GE estimates normal discharges will be 24 m^3/day based on the capacity of the SWSD pump, with a maximum discharge rate of 240 m^3/day.

Non-radioactive storm drain (NSD)

The NSD receives aqueous discharges from the non-radioactive drains in non-controlled areas of the site from a number of different systems on-site. These include RCW, TCW, heating ventilation and conditioning (HVAC) cooling waters (emergency and normal), station service air system (SA), instrument air system (IA). These discharges differ from the SWSD in that they will be purified water rather than sea water.

The NSD discharges to the NSD sump from where it is pumped to sea via the seal pit. The discharge rate from the NSD is determined by the capacity of the NSD pump. Discharges from the

NSD are not constant. Hitachi-GE estimates normal discharges will be 24 m^3/day based on the capacity of the SWSD pump, with a maximum discharge rate of 240 m^3/day.

Hitachi-GE states that non-radioactive contaminants in the NSD discharges are sodium nitrite used as a corrosion inhibitor in the auxiliary equipment cooling systems with dosing levels of up to 300 ppm.

Radioactive drainage networks

The radioactive waste drainage network comprising of the CAD, HCW, LCW and LD make up the liquid waste management system (LWMS). The purpose of the LWMS is to collect, process, store and handle radioactive liquid wastes generated as part of the operation of the UK ABWR. This includes containing any leakages and any water drained from the closed loop systems of the primary circuit and the fuel pond.

The intention is to re-use the treated water from within the LWMS back in the process so that aqueous discharges are minimised as far as possible.

Controlled area drain (CAD)

The CAD collects drainage from the non-radioactive equipment in the controlled areas within the reactor and turbine buildings.

Hitachi-GE states that the CAD system should be free from radioactive contamination. Non-radioactive contaminants are likely to be sodium nitrite, used as corrosion inhibitor, discharged to the CAD from drain down of the RCW, TCW, HVAC systems within the controlled areas.

Hitachi-GE states the typical discharge is expected to be 3 m^3/day.

High chemical impurities waste (HCW)

The HCW system is designed to treat radioactive or potentially radioactive contaminated water with high levels of chemical impurities compared to the LCW system (see below).

Hitachi-GE initially stated that the HCW system will contain various non-radioactive and radioactive contaminants but did not specify what these are. We raised a Regulatory Observation (RO-ABWR-0070) to request further information on the likely contaminants in the HCW aqueous waste stream. In response Hitachi-GE states that the main feeds into the HCW will be waste water from the chemical analysis laboratory and the condensate demineraliser drains. Chemicals present in the waste water from the chemical analysis include small quantities of minerals acids (hydrochloric, nitric and sulphuric), sodium bicarbonate, potassium permanganate, silver nitrate and cation and anion eluents from chromatography. Hitachi-GE has provided a table of chemicals used in the chemical analysis based on operational practice for Japanese ABWR. The usage of individual chemicals at any one time ranges from <100 ml up to a maximum of 2 litres. Annual usage is from 200 ml up to approximately 8 litres. We have included the following Assessment Finding to make it clear to any potential future operator that all aqueous waste streams need to be clearly characterised prior to applying for a water discharge activity environmental permit.

Assessment Finding 16 – A future operator shall appropriately characterise all aqueous waste streams in its water discharge activity permit application. This shall include identification of all significant contaminants (including biocides, detergents and metals), the concentrations and the volumes being discharged to the environment.

Hitachi-GE states that the contaminants from the HCW aqueous waste stream will be removed from the effluent stream into the spent resins and concentrated waste tank as part of the treatment process (see ‘Treatment’ section of this report).

Sodium hydroxide (demineraliser) and sodium dihydrogen phosphate (corrosion inhibitor) are added to the HCW system. Hitachi-GE states that these chemicals will be removed by the treatment process and not discharged to the environment (see ‘Treatment’ section of this report).

As the purpose is to reuse the aqueous waste from the HCW in the UK ABWR there are only low volumes discharged to the environment. These discharges occur on a batch basis. Hitachi-GE reports operational Japanese ABWRs discharge on average 2.5 batches of HCW aqueous waste per year, totalling approximately 288 m^3/year, which is equivalent to 115 m^3/batch.

Note - This volume is less than that used in the assessment of aqueous radioactive waste disposal (Environment Agency, 2016), as that assessment is based on a worse-case scenario of all HCW being discharged to the environment.

Low chemical impurities waste (LCW)

The LCW system is designed to treat relatively large volumes of radioactive or potentially radioactive contaminated water with lower levels of chemical impurities compared to the HCW. Similar to the HCW, the effluent is treated for re-use within the UK ABWR.

Hitachi-GE states that the effluent will contain radioactive and non-radioactive contaminants but does not specify what these are. Hitachi-GE states that the contaminants will be removed from the effluent stream as part of the treatment (see 'Treatment' section of this report).

Hitachi-GE states that there are no additional chemicals added to the LCW waste stream. There are no discharges to sea direct from the LCW as any aqueous waste not suitable to be reused will be treated via the HCW and will form part of the HCW aqueous waste stream.

Laundry drain (LD)

The LD receives effluent from the laundry, showers and hand washing facilities. The quantity discharged from the LD system has been estimated at 2,240 m^3/year. This is based on 200 people per day entering the controlled area during normal plant operations, 1,800 people per day during plant inspection and an operating regime of 11 months normal operation and one month outage for periodic inspection. The only contaminants are detergents (750 litres/year), and low levels of suspended solids and organic matter.

Hitachi-GE initially stated that the selection of detergent will be undertaken at site-specific stage.

While we accept that the final choice of detergent is a site-specific matter we expect Hitachi-GE to provide information on the types of detergent compatible with the UK ABWR design. We raised a Regulatory Observation (RO-ABWR-0070) requiring further information on the likely detergents to be used and levels of active ingredients expected in the discharge.

In response to RO-ABWR-0070 Hitachi-GE states that anionic surfactant based detergent would be suitable, and has provided information on a commercially available product with an active ingredient of sodium;1,4-bis(2-ethylhexoxy)-1,4-dioxobutane-2-sulfonate.

Boiler blow-down

Blow-down effluent will be generated as part of the normal operation of the auxiliary boilers. Chemicals will be needed to treat the boiler feed water and Hitachi-GE states for the purpose of GDA these have been assumed to be phosphate to provide pH control and hydrazine as a de-oxidiser. Hitachi-GE originally stated that hydrazine in the boiler water system would be degraded into water and ammonia in the presence of oxygen. This occurs at high temperatures and Hitachi-GE have now confirmed that the temperatures required for this reaction will not be experienced, and that hydrazine will be degraded into water and nitrogen.

Hitachi-GE initially stated that the volume of boiler blow-down effluent will not be known at GDA, and the quantities of ammonia and phosphate present in the final effluent will also not be known.

While the exact volume of boiler blow-down and dosing levels of the treatment chemicals can only be determined at the site-specific stage we expect Hitachi-GE to provide an indication of the expected amounts. We raised a Regulatory Observation (RO-ABWR-0070) requiring further information on the concentration/levels of contaminants and volumes of boiler blow-down expected to be discharged.

In response to RO-ABWR-0070 Hitachi-GE states that the estimated blow-down from each boiler operating at full load is 4.7 m^3/day. The level of phosphate in the blow-down is expected to be 3 ppm. Dosing with hydrazine is expected to be at 0.2 ppm.

Purified water treatment facility (PWTF) effluent

Effluent will arise from producing purified water to use in the auxiliary boilers.

Initially, Hitachi-GE stated that the purified water would be provided from a demineraliser plant and that sodium hydroxide and sulphuric acid would be used to regenerate the ion exchange resins. No information was provided on the volume of boiler blow-down to be discharged or levels of contaminants in the effluent. We raised a Regulatory Observation (RO-ABWR-0070) requiring further information.

In response to RO-ABWR-0070 Hitachi-GE now states that for the GDA the PWTF will use reverse osmosis and electro-deionisation technologies to convert towns-water to high quality deionised water.

Hitachi-GE states that the reverse osmosis and electro-deionisation is suitable when the feed-water is of higher quality than that required for ion exchange. Hitachi-GE states that ion exchange is typically used in Japan when the source of the feed-water is a lake or river. The UK ABWR is based on the feed-water to be supplied from towns-water. This should be higher quality than lake or river feed-water and suitable for reverse osmosis and electro-deionisation.

The PWTF will produce 450 m^3/day of effluent which will contain the same constituents as towns-water but at double the concentration. This will require 900 m^3/day of feed-water.

We accept, for the purpose of GDA, that both demineralised water treatment and reverse osmosis and deionisation are suitable for generating purified water.

It should be noted, however, that any future operator will need to justify the additional water usage for reverse osmosis and electro-deionisation compared to the water demineralisation plant.

Special liquid waste

Hitachi-GE initially included information on 3 special liquid waste streams. We raised a Regulatory Query (RQ-ABWR-0085) requiring more information on their composition and how they were treated and disposed of. Hitachi-GE has subsequently confirmed these waste streams are not discharged to surface water.

4.3.2. Effluent treatment

Cooling water system discharges

Hitachi-GE states that there will be no treatment of the 3 cooling water system (CW, RSW & TSW) discharges as they should be free from contamination, with the exception of biocides (and degradation products) and potentially low levels of iron.

We accept, for the purpose of GDA, that given the low levels of contaminants and large volumes being discharged that treatment is not necessary for these waste streams.

Discharges of the cooling water will be monitored to ensure that the discharge criteria are met.

Non-radioactive drainage networks

There is no treatment of the SWSD discharges, although monitoring is carried out to ensure that the final discharge criteria are met. It is expected that this discharge will not contain any contamination and we accept, for the purposes of GDA, that treatment of the SWSD effluent is not necessary.

There is no treatment of the NSD effluent within the NSD system. A radiation monitor is installed in the discharge line and if radiation is detected the effluent can be transferred, via temporary facilities to the radiation waste treatment facility.

We accept, for the purpose of GDA, given the very low levels of contamination (maximum 300 ppm of sodium nitrite), treatment of the NSD effluent is not necessary.

Radioactive drainage networks (LWMS)

Hitachi-GE states the purpose of treatment within the LWMS is to enable the aqueous radioactive waste to be reused within the UK ABWR. Aqueous waste from the LD contains detergents, and is unsuitable for reusing within the UK ABWR.

There is no direct treatment of the CAD system effluent as there is minimal contamination expected. The effluent will be sampled and analysed for radioactive and chemical contaminants. If the effluent meets the discharge criteria then it will discharged to sea, otherwise it will be transferred to the HCW system for treatment.

Separate treatment systems are in place for the HCW, LCW and LD. Hitachi-GE initially provided limited information on how these waste streams are treated.

We raised a Regulatory Observation (RO-ABWR-0070) requiring further information on the treatment of HCW, LCW and LD to demonstrate why these treatment processes are suitable for the non-radioactive contaminants.

Hitachi-GE states each aqueous waste stream within the LWMS can be recirculated multiple times to ensure effective treatment takes place. There are a number of linkages within the LWMS to enable the aqueous waste to be transferred to the most appropriate treatment system. Hitachi-GE has provided the criteria for the effluent transfer linkages. These are based on the level of radioactivity, conductivity, chemical oxygen demand (COD), suspended solids, pH, chloride, sulphate or total organic carbon as appropriate.

High chemical impurities waste (HCW)

The HCW effluent is treated using an evaporator to concentrate and remove insoluble impurities followed by a demineraliser to remove soluble impurities. The effluent is sampled following treatment, and if suitable, is reused in the reactor, otherwise it will be recycled through the treatment process.

If there is insufficient capacity within the reactor system, the effluent will be discharged to sea, but only if the discharge criteria are met.

Hitachi-GE states that the evaporator is efficient at removing the majority of the contaminants in the HCW effluent, which will enable them to be removed as solid waste. Volatile material will be carried over and is treated using the demineraliser.

Hitachi-GE states that evaporators are used in Japanese ABWRs and lead to significant volume reductions compared to other technologies. Decontamination factors (DF) of 1000 are achievable depending on the evaporator choice and chemical composition of the HCW.

Hitachi-GE also references the International Atomic Energy Agency report on the ‘Handling and Processing Radioactive Waste from Nuclear Applications’ (IAEA, 2001), which describes how evaporation is widely used in the nuclear industry as an effective method for treating effluent that is both radiological and chemically contaminated.

The demineraliser removes soluble impurities utilising ion exchange resins. Hitachi-GE states that ion exchange resins are recognised as industry standard relevant good practice in the nuclear industry for removing radionuclides and are used extensively on nuclear power plants in the UK.

Hitachi-GE also states that ion exchange resins will work equally well for non-radioactive soluble impurities.

We accept, for the purposes of GDA, that using an evaporator and demineraliser is suitable treatment for HCW.

Low chemical impurities waste (LCW)

The LCW effluent is treated using filters to remove insoluble impurities followed by ion exchange to remove soluble impurities. The effluent is sampled following treatment and, if suitable, is reused in the reactor, otherwise it will be recycled through the treatment process.

The filtration system utilises hollow fibre membrane filters to remove the insoluble impurities within the LCW. The demineraliser utilises ion exchange resins as described in the HCW section.

Hitachi-GE states that the performance of the LCW system has been obtained through operational experience and feedback on the filtration system. Analysis of samples taken from the inlet and outlet of the LCW system demonstrates a DF of approximately 100.

We accept, for the purposes of GDA, that using filtration and a demineraliser is suitable treatment for the LCW.

Laundry drain (LD)

The LD effluent is treated using a combined filtration system to remove suspended solids and organic materials. The effluent will be sampled following treatment and discharged to sea if the discharge criteria are met, otherwise it will be recycled through the treatment process.

The filtration system consists of a packed bed pre-filter, followed by an activated charcoal adsorption unit and finally a pre-coat carbon filter. Hitachi-GE states that the filtration system provides a DF of 300 for insoluble contaminants.

The pre-filter removes coarse solid material. The activated charcoal adsorption unit contains bead activated carbon to adsorb organic impurities and smaller suspended solids that pass through the pre-filter. The pre-coat filter contains cartridges with a fabric sock pre-treated with granular activated carbon to trap small-sized suspended solids.

We accept, for the purposes of GDA, that filtration incorporating the use of activated carbon to remove organic materials, is suitable treatment for aqueous waste from the laundry operations within the UK ABWR.

Boiler blow-down

Hitachi-GE states that there is no treatment of the boiler blow-down. The effluent will be stored prior to being discharged in batches for mixing with the cooling water discharge in the seal pit.

We accept, for the purposes of GDA that given the minimal volumes of boiler blow-down generated (4.7 m^3/day), the low levels of contaminants and the massive dilution from cooling water that treatment of the boiler blow-down is not necessary.

Purified water treatment facility (PWTF) effluent

There is no treatment of the PWTF effluent. The effluent will be stored prior to being discharged in batches for mixing with the cooling water discharge in the seal pit.

We accept, for the purposes of GDA, that given the effluent is only twice concentrated towns-water, treatment is not necessary.

Rainwater

Hitachi-GE states that treatment of rainwater will depend upon where it falls within the UK ABWR site. The final strategy for managing rainwater will be site-specific and depend upon the site topography, location and layout. At the GDA stage, rainwater within the inner fence will drain to the seal pit and be discharged with the cooling water. Rainwater from outside the inner fence may go direct to sea. Hitachi-GE states that drainage systems will have appropriate measures in place to manage spills of chemicals such as oil interceptors.

We agree that the final site layout and appropriate measures for managing rainwater only can only be determined at the site-specific stage.

4.3.3. Discharge criteria

Discharges to the sea of aqueous wastes will be from the cooling water systems (CW, TSW and RSW), boiler-blowdown, PWTF effluent, NSD, SWSD, CAD, HCW and LD. The cooling water discharges will be continuous, whereas the other discharges will be on an intermittent batch basis. All discharges will be via the seal pit.

Hitachi-GE has provided criteria for discharges to sea from the NSD, SWSD, CAD and LD and these are presented in the table below (Table 3). Hitachi-GE states that these are the criteria for the Japanese ABWR and are presented to demonstrate the level of control in place for an operational nuclear power plant. The finalised discharge criteria will be determined at the site-specific stage.

Table 3. Hitachi-GE discharge criteria for a Japanese ABWR

Parameter	Level	
pH	5.8 – 8.6	
Chemical oxygen demand (COD)	<30 mg/l	Daily maximum
	<20 mg/l	Daily average
Suspended solids	<20 mg/l	Daily maximum
	<15 mg/l	Daily average
Concentration of normal hexane extract	<3 mg/l	Daily maximum

We accept that the final discharge criteria for any discharges to surface water can only be determined at the site-specific stage.

The criteria above indicates that the levels of suspended solids and organic material (as measured by COD) in the aqueous wastes discharged are low. The pH range is comparable with operational nuclear power plants in the UK. The concentration of normal hexane extract is a measure of the level of oil in the discharge. We would expect any aqueous discharge to be free from any visible oil and it is expected that the <3 mg/l would meet that criteria.

Hitachi-GE has also included the acceptance criteria required for the condensate storage tank (CST), which is where the aqueous waste is stored to reuse in the UK ABWR (Table 4). This acceptance criteria is presented in the table below.

Hitachi-GE states that the HCW aqueous waste will only be discharged to sea if there is insufficient storage capacity within the CST. This indicates that any HCW discharge to sea meets this acceptance criteria.

Table 4. Hitachi-GE acceptance criteria for reuse via the CST for the UK ABWR

Criteria	Acceptance threshold
Conductivity	<100 µS/m
pH	5.6 – 8.0
Chloride (Cl^{-})	<20 ppb
Sulphate (SO_4^{2-})	<20 ppb
Total organic carbon (TOC)	<400 ppb

The levels of chloride, sulphate and TOC are extremely low, which indicates minimal contamination. The pH range is similar to those for operational nuclear power plants within the UK. The conductivity of less than 100 µS/m indicates that there are low levels of ionic species present in the HCW aqueous waste.

4.3.4. Environmental impact

Hitachi-GE has identified that only a limited number of non-radioactive contaminants are likely to be in the aqueous waste streams which are discharged to sea. These are:

- sodium hypochlorite and degradation products from use as a biocide in the cooling water systems
- iron from dosing of the cooling water systems at a maximum concentration of 3 ppm
- nitrite as a corrosion inhibitor in auxiliary equipment cooling systems at concentrations of 300 ppm
- detergents from use in the laundry
- phosphates (and hydrazine under a worse case) in the boiler blow-down

Environmental quality standards (EQS) for discharges into coastal waters are available for iron and chlorine (as TRO).

- Iron – 1 mg/l
- Chlorine (as TRO) – 0.01 mg/l

Hitachi-GE states there is no EQS for hydrazine. A no observed effect concentration (NOEC) of 0.5 µg/l has been identified in an Environment Agency report on chemical discharges from nuclear power stations (Environment Agency, 2011a). The same report also states the most stringent USEPA criterion for phosphate as 10 µg/l.

Hitachi-GE has undertaken an environmental impact assessment for discharges of iron. The impact assessment follows the Environment Agency H1 Guidance Methodology (Environment Agency, 2011b) by comparing the discharge concentration (DC) and process contribution (PC) of the iron against the EQS. The DC is the concentration at the end of pipe prior to discharging into the environment. The PC is the concentration in the environment following initial dilution.

Table 5. The results from the H1 impact assessment

Chemical	Annual Release (kg)	DC (µg/l)	PC (µg/l)	EQS (µg/l)	DC/EQS (%)	PC/EQS (%)
Iron (0.03 ppm)	4783	2.69	0.54	1000	0.27	0.05

The results show that there is minimal environmental impact from the discharge of iron to sea. The PC and DC are worse case as they are based on discharge volumes of the TSW and RSW and do not take into consideration dilution from the CW discharge.

We accept, for the purposes of GDA, that the environmental impact of iron discharged to sea via the cooling water from the UK ABWR will be acceptable.

Hitachi-GE initially stated it was unable to carry out an environmental impact on any of the other substances identified given the lack of information on the levels of contaminants and/or volumes of various waste streams.

We raised a Regulatory Observation (RO-ABWR-0070) requiring an impact assessment to be made on the discharges of (1) biocides in the cooling water, (2) HCW drain, (3) laundry drain, (4) boiler blow-down and (5) effluent from demineraliser plant.

In response to RO-ABWR-0070, Hitachi-GE has undertaken a semi-quantitative impact assessment on biocides (sodium hypochlorite), phosphate, hydrazine and detergent.

Biocides – Sodium hypochlorite

When injected into water the chlorine in the sodium hypochlorite forms a number of residual oxidising species, including hypochlorous acid (HOCl) and free chlorine as well as small volumes of by-products. These are termed total residual oxidants (TRO). The EQS for chlorine (as TRO) in sea water is 0.01 mg/l.

Hitachi-GE states that the dosing strategy for the sodium hypochlorite will be designed to ensure that the EQS is not exceeded at the edge of the mixing zone while still ensuring effective bio-fouling treatment. This is expected to result in a concentration of 0.1 mg/l at the cooling water outfall.

Based on this, for the purposes of GDA, the environmental impact from sodium hypochlorite dosing in the cooling water for the UK ABWR is likely to be acceptable.

Boiler blow-down (phosphate and hydrazine)

Phosphate is present at a maximum concentration of 3 ppm in the boiler blow-down. Based on a minimum dilution of 9,100 m^3/hour from cooling water (lowest cooling water flow expected during outage), Hitachi-GE states that the highest (worst-case) predicted concentration of phosphate at the cooling water outfall is 1.5 µg/l. This is below the 10 µg/l USEPA criterion.

Hydrazine, under a worst-case scenario, could be present at 0.2 ppm if no degradation were to occur. Based on dilution of 9,100 m^3/hour from cooling water, Hitachi-GE states that the highest predicted concentration of hydrazine is 0.1 µg/l at the cooling water outfall. This is below the NOEC level of 0.5 µg/l.

Hitachi-GE states that should there be limited degradation of hydrazine then measures would be implemented to remove hydrazine in the boiler blow-down. It is possible to oxidise hydrazine by adding sodium hypochlorite, which would be present in the cooling water discharge. It is highly unlikely that hydrazine will be present in the final discharge from the cooling water outfall.

We conclude, for the purposes of GDA, that the environmental impact from the phosphate and hydrazine in the boiler blow-down from the UK ABWR is likely to be acceptable.

Detergents

Hitachi-GE states that, for the purpose of GDA, an anionic surfactant based detergent will be used. The active ingredient (sodium;1,4-bis(2-ethylhexoxy)-1,4-dioxobutane-2-sulfonate) is present at a concentration of up to 75% and is reported to have no toxic effects to the environment or aquatic organisms.

The amount of detergent used is estimated to be 750 litres/year compared to an annual discharge of 2240 m^3 of aqueous waste from the laundry. This will be significantly diluted by the cooling waste discharge (minimum of 9100 m^3/hour).

We conclude, for the purposes of GDA, that the environmental impact from the detergents as part of the laundry discharge from the UK ABWR is likely to be acceptable.

Sodium nitrite

Sodium nitrite will be present at a maximum level of 300 ppm in the CAD and NSD aqueous waste streams.

Given the minimal volumes discharged (3 m^3/day from the CAD and up to 240 m^3/day from the NSD) and the dilution from the cooling water (minimum of 9,100 m^3/hour), we conclude that the environmental impact from the sodium nitrite corrosion inhibitor discharged from the UK ABWR is likely to be acceptable.

HCW discharges

Hitachi-GE has identified the main chemical contaminants in the HCW aqueous waste stream from the chemical analysis laboratory. The annual volumes are minimal up to a maximum of a few litres. We believe the environmental impact will be acceptable. This is based on:

- the minimal volume of HCW discharged (288 m^3/year based on Japanese operational experience)
- the very significant dilution from cooling water (typically 203,000 m^3/hour, minimum 9,100 m^3/hour)
- criteria for reusing HCW that infers minimal levels of organic contamination as indicated by a TOC (<400 ppb), minimal levels of ionic species (inorganic/ metals) as indicated by conductivity (<100 µS/m) and minimal levels of sulphate (<20 ppb) and chloride (<20 ppb)

Note: It is only HCW aqueous waste that meets the criteria for reuse, which is discharged to the environment when there is insufficient storage capacity on the CST.

A future operator of a UK ABWR will also need to carry out an environmental impact assessment for all substances discharged to surface water as part of a water discharge activity permit application.

4.3.5. Impact of thermal discharges

Hitachi-GE states that in order to assess the environmental impact of the thermal plume from the cooling water discharge accurate information is required on the behaviour of the receiving surface water and how this behaves with the various substances discharged. This can only be achieved using computational modelling supported by localised monitoring data for the specific site.

Hitachi-GE has proposed that no thermal modelling is undertaken at the GDA stage on the basis that the thermal impact is site-specific.

We accept this proposal and the thermal impact of discharges to surface water has been agreed to be out of scope of GDA.

4.3.6. Identification of options for beneficial use of waste heat

Hitachi-GE has determined that 2,581 MW of waste heat will be generated from the cooling water systems with a mean temperature of 23°C. This is regarded as low grade heat and limits the recovery and application.

Hitachi-GE has provided information on a number of options for using the beneficial waste heat from the cooling water. These include:

- crop growing (glasshouses)
- aquaculture (fish farming)
- heating of road/de-icing airport runway surfaces
- heat for algae bio-diesel growth
- desalination
- district heating

Each of these options has been considered in turn and the practicalities and limitations of implementation have been discussed. Hitachi-GE states no option is readily viable for the waste heat from the UK ABWR and we accept this.

4.4. Conclusion

Following our assessment of the surface water discharges we conclude that:

- the UK ABWR will have non-radioactive discharges to surface water and will require an environmental permit for a water discharge activity
- the UK ABWR could be granted a permit for under The Environmental Permitting (England and Wales) Regulations 2016 for discharges to surface water at site specific permitting. However, any future operator will need to provide more detailed information on the volumes and composition of the various aqueous waste streams and demonstrate that the environmental impact from the discharges is acceptable

5. Discharges to groundwater

Discharges to groundwater are controlled by The Environmental Permitting (England and Wales) Regulations 2010 (GB Parliament, 2016). An environmental permit is required for any discharge either directly or indirectly into groundwater unless the activity is exempt. Further information can be found on the GOV.UK website at www.gov.uk/guidance/discharges-to-surface-water-and-groundwater-environmental-permits.

5.1. Assessment objectives

Our assessment in this area was aimed at:

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

5.2. Hitachi-GE documentation

Hitachi-GE provided the information required by the P&ID in Section 6 of the 'Other Environmental Regulations' document (Hitachi-GE, 2017). This was split into 3 parts:

- P&ID requirements (Section 6.1)
- Regulatory context (Section 6.2)
- UK ABWR discharges to groundwater (Section 6.3)

5.3. Assessment

Hitachi-GE states that the UK ABWR does not include any requirement for routine discharges to groundwater and there will be no intentional discharges to groundwater.

Hitachi-GE states that the UK ABWR design will utilise BAT to prevent accidental leaks and spillages of non-radioactive pollutants that could cause pollution of the land or groundwater. These will include physical measures such as:

- tank bunding
- tertiary containment
- hard surfacing in spill risk areas (for example, loading bays, tanker bays etc.)
- use of interceptors on drainage systems
- provision of spill kits
- a plumbing and drainage system to collect and segregate potential leaked water (including fire-water)

The detailed site layout design can only be determined at the site-specific stage, therefore the exact arrangements for drainage, bunding (secondary containment) and tertiary containment are not known at GDA. The measures highlighted above represent good practice and we will ensure that these are implemented during construction at specific sites.

Hitachi-GE also states that the following measures will be implemented to minimise spillages.

- staff training in spill prevention and emergency response
- emergency response exercises

- vehicle routing
- delivery and off-loading procedures
- inspection and preventative maintenance programmes for structures providing pollution prevention functions

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

5.4. Conclusion

Following our assessment of discharges to groundwater we conclude that:

- there should be no intentional discharges to groundwater and an environmental permit for a groundwater activity will not be required
- the UK ABWR should have appropriate measures in place to prevent pollution of the land or groundwater

6. Operation of installations (combustion plant and incinerators)

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

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

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

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

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

6.1. Assessment objectives

Our assessment in this area was aimed at deciding if the UK ABWR required an environmental permit:

- for combustion activities and, if so, determining whether we could permit such an installation
- under the Greenhouse Gas Emissions Trading Scheme Regulations 2012 and, if so, assessing how greenhouse gas monitoring will be carried out
- for the incineration of waste and, if so, determining whether we could permit such an installation

6.2. Hitachi-GE documentation

Hitachi-GE provided the information required by the P&ID in Section 7 of the 'Other Environmental Regulations' document (Hitachi-GE, 2017). This was split into 8 parts:

- Introduction (Section 7.1)
- P&ID requirements (Section 7.2)
- Regulatory context – combustion activities (Section 7.3)
- UK ABWR assumptions (Section 7.4)
- UK ABWR combustion plant installation (Section 7.5)
- Comparison with sector guidance note (Section 7.6)
- Impact assessment (Section 7.7)
- Greenhouse gas emission monitoring (Section 7.8)

6.3. Assessment

6.3.1. Incineration

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

6.3.2. Combustion

Hitachi-GE states that the combustion plant for the UK ABWR will consist of:

- 3 standby emergency diesel generators (EDGs), each with a thermal input of 18 MW_{th} to supply 7.4 MW_e of electricity
- 2 standby diesel driven back-up building generators (BBGs), each with a thermal input of 6.14 MW_{th} to supply 2.4 MW_e of electricity
- One diverse additional generator (DAG), with a thermal input of 18 MW_{th} to supply 7.4 MW_e of electricity
- 2 fire protection pumps, each with a thermal input of <3 MW_{th}
- 2 auxiliary diesel-fired boilers, each with a thermal input of 24.1 MW_{th}

The combustion activity will require an environmental permit from us as the total thermal input of the relevant combustion plant is greater than 50 MW.

The EDGs, BBGs and DAG are classed as nuclear safety equipment and designed to supply back-up emergency electrical power in the event of loss of power from the national grid. The EDGs and BBGs will operate together, if required, and will start up automatically on receipt of a loss of power signal. The DAG is there to provide back-up if there is a common cause failure of the EDGs and will be started manually.

The EDGs and BBGs will operate during commissioning, routine testing and in the case of a loss of power. A single commissioning test will be undertaken for each EDG and BBG and will last for approximately 6 hours. Routine testing will consist of a regular test of <3 hours every 18 months and a monthly surveillance test for <1 hour.

The auxiliary boilers provide steam to the site during start-up, normal operation and shutdown. Under normal operation both boilers are expected to operate at full load in winter and one boiler at 50% load during the summer, therefore, at least one boiler will be operational during most circumstances.

Hitachi-GE states that the final selection of the combustion plant (design of diesel generators and auxiliary boilers) will be carried out at the site-specific stage. This will be based on a review of suitable combustion plant and associated plant available, and the selection will be based on the assessment of BAT.

We have raised the following Assessment Finding to ensure that any future operator provides enough information on the proposed combustion plant, so that the relevant regulator can appropriately determine a combustion activity permit application.

Assessment Finding 17 – A future operator shall specify the minimum performance parameters of the combustion plant in its application for an installations permit.

Hitachi-GE has compared the proposed technology for the combustion plant against the Environment Agency Combustion Sector Guidance Note EPR1.01 (Environment Agency, 2009) and the ‘How to comply with your environmental permit’ guidance (Environment Agency, 2013b). We have reviewed the information submitted and have the following comments:

- The site report is a site-specific issue and is, therefore, not available for assessment at GDA.

- The EDGs, BBGs and DAG are required for nuclear safety and are expected to only run for short periods of time. They will need to respond when required so we accept that energy efficiency is not a primary consideration.
- The main raw materials to be used will be diesel, water and lubrication oil. Annual diesel oil usage is estimated to be 22,776 tonnes based on one boiler operating continuously. Lubrication oil is estimated to be 5,000 litres/year. Other chemicals used in much lower quantities will be glycol, biocides and boiler water treatment chemicals.
- There will be no direct discharges to water from the combustion installation. Boiler blow-down and cooling water discharges will be directed to the wider cooling water system within the UK ABWR. These volumes are minimal compared with the surface water discharges associated with the nuclear reactor plant.
- Point source emissions to air will consist primarily of oxides of nitrogen (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO) and particulate matter (PM).
    - Emissions of SO_2 will be minimised by using ultra-low sulphur fuel (<0.001% by weight). BAT can only be determined at site-specific stage but, in principle, we accept this as BAT.
    - Emissions of NO_x from the auxiliary boilers will be minimised by using low NO_x burners. BAT can only be determined at site-specific stage but, in principle, we accept this as BAT.
    - Minimising emissions of NO_x from the EDGs, BBGs and DAG will rely on engine design and will not be finalised until the site-specific stage. Hitachi-GE has quoted a typical discharge concentration of 2,216 mg/m^3 for the EDGs. The operator will need to carry out a BAT options appraisal as part of the permit application to demonstrate that the chosen engine design minimises emissions of NO_x. Improvements are taking place with engine design technology and we expect the operator to review the latest available equipment to identify BAT.
    - Emissions of carbon dioxide and particulate matter will be minimised by using combustion efficiency techniques such as combustion chamber design, optimised fuel/air mixing and tuning of engines. BAT can only be determined at the site-specific stage but, in principle, we accept this as BAT.
    - As part of a permit application, the operator will also have to demonstrate that the combustion plant will meet relevant emission limit values (ELVs) for SO_2, NO_x and PM.
- We are unlikely to require continuous emission monitoring for emissions to air for the combustion plant given the size of the auxiliary boilers, and the size and frequency of operation of the EDGs, BBGs and DAG. The auxiliary boilers will likely need monitoring each year and the EDGs, BBGs and DAG monitoring every 3 years.
- The operator will need to demonstrate that there is a suitable management system in place for the installation. This is a site-specific issue and has not been addressed at the GDA stage. Hitachi-GE suggests that an externally accredited environmental management system is likely to be implemented such as BS EN 14001 or Eco Management and Audit Scheme (EMAS) and we agree with this suggestion.

  We expect a future operator to have an integrated management system across the whole of the nuclear power plant site that incorporates the arrangements for the combustion installation.
- An assessment against noise, odour and vibration has not been undertaken at GDA. This will be required as part of the site-specific permit application. Hitachi-GE states that all equipment for the combustion plant will be specified with suitable noise and vibration attenuation where appropriate. Examples include appropriate silencing equipment for generator engine exhausts and pressure relief valves. Hitachi-GE states that there is unlikely to be any specific measures for odour beyond those indicative measures specified in relevant guidance and we agree with this.

Hitachi-GE has undertaken an impact assessment of emissions to air from the combustion plant within the UK ABWR to demonstrate that the emissions could be shown to be acceptable. The impact assessment was carried in 2 stages:

- a screening assessment of the main process emissions (NO_2, SO_2, CO & PM) using the methodology in Environment Agency Horizontal Guidance Document H1 Annex F (Environment Agency, 2011c)
- a further screening assessment of the short term NO_x emissions from the EDGs using the USEPA regulatory air dispersion model AERMOD

The initial screening assessment was used to assess the ground level concentrations of the combustion plant emissions against the applicable relevant short-term and long-term air quality standards. The assessment was based on the operation of a single EDG, a single BBG and both auxiliary boilers. It was agreed that the DAG did not need to be included in the assessment as it will only be used as a replacement for an EDG and will, therefore, never operate at the same time. The long-term assessment was based on 20 hours of operation each year for both the EDGs and BBGs.

The initial screening assessment showed that the ground level concentrations of emissions of NO_2, SO_2 and PM from the EDGs and BBGs were significantly below the relevant long-term air quality standards (there is no standard applicable for CO). Long-term emissions from the auxiliary boilers were below air quality standards for SO_2 and PM but nearly 4 times above for NO_2. Short-term emissions were significantly greater than the air quality standard for NO_2 from both the EDG and BBG (up to 175 times) and 9 times above from the auxiliary boilers.

Based on the findings of the initial screening assessment, a Regulatory Observation (RO-ABWR-0060) was raised requiring further work to demonstrate that the emissions to air could be shown to be acceptable.

The second screening assessment was undertaken to provide a more realistic assessment of the impact of short-term emissions of NO_x from the diesel generators using a more sophisticated dispersion model. The H1 screening tool has limitations, particularly when assessing short-term impacts, and can be over-pessimistic. The initial assessment using the H1 screening tool assumed an effective stack height of zero in the assessment due to the EDGs and BBGs having minimal stacks and being located in buildings next to significantly larger buildings. The second assessment was carried out using a variety of stack heights to demonstrate that by increasing the stack height the emissions could be shown to be acceptable. Increasing stack height increases the level of dispersion of any pollutants and therefore reduces ground level concentration.

The AERMOD screening assessment indicates that increasing the stack heights of the EDGs and BBGs to around 30 metres will reduce the impact of the short-term emissions of NO_x to acceptable levels. This type of stack height is not unrealistic on a nuclear site.

Note: Hitachi-GE has recently made some small changes to the dimensions of the EDG and Rad Waste Buildings but have not resubmitted any of the air dispersion modelling. The changes will not alter the results from the H1 screening tool as the effective stack height used was zero. The changes are likely to alter the results from the AERMOD screening assessment, although this is not expected to be in a significant way, as there will only be a relatively small decrease in the effective height used in the modelling.

The final stack heights for the combustion plant are site-specific issues for the operator. It is acknowledged that the final plant layout and further detailed dispersion modelling may reduce the final stack height needed. The purpose of these screening assessments was to show that the impact of emissions from the combustion plant on the UK ABWR could be realistically reduced to acceptable levels to potentially allow a permit to be issued. We do not believe that the changes to the building dimensions alter this position.

Furthermore, any future operator will have to carry out site-specific air dispersion modelling as part of the permit application to demonstrate compliance with air quality standards and to demonstrate that the environmental impact from the combustion plant installation is acceptable. As part of the air dispersion modelling, the operator will need to ensure that the exact building dimensions are used.

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

6.3.3. Greenhouse gas monitoring

The UK ABWR combustion activity will require a permit from us under the Greenhouse Gas Emissions Trading Regulations as the total thermal input of the relevant combustion plant is greater than 20 MW.

Hitachi-GE states that the proposed approach to monitoring of greenhouse gas emissions will meet the requirements contained in ‘General guidance for installations (MRR1)’, which provides guidance on how to meet the requirements of the Monitoring and Reporting Regulations for Greenhouse Gas Emissions (EU, 2012). It will follow the standard method used for calculating emissions as outlined in MRR1. This involves measuring fuel inputs and process inputs and applying appropriate emission, process and oxidation factors to calculate the total emissions.

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

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

6.4. Conclusion

Following our assessment of the operation of installations we conclude that:

- the UK ABWR combustion plant (diesel generators and auxiliary boilers) will be a Part A(1) installation as described in Section 1.1 of Chapter 1 in Part 2 of Schedule 1 of The Environmental Permitting (England and Wales) Regulations 2016 and will require an environmental permit from the Environment Agency
- in principle we should be able to issue a permit under The Environmental Permitting (England and Wales) Regulations 2016 for the operation of the combustion plant, but any application for a permit will need:
    - a BAT assessment for the chosen diesel generators and auxiliary boilers
    - to demonstrate that the auxiliary boilers comply with the ELVs for medium combustion plants
    - site-specific modelling to demonstrate compliance with air quality objectives
- the UK ABWR combustion plant will require a permit under the Greenhouse Gas Emissions Trading Scheme Regulations 2012

7. Control of Major Accident Hazard Regulations (COMAH)

The COMAH Regulations apply to establishments that store or use quantities of named or generic categories of dangerous substances above specified qualifying thresholds. Examples of dangerous substances are chemicals, oils or explosives. Radioactive substances that are used or stored on nuclear licensed sites are excluded from the COMAH Regulations. This is because the hazards are already addressed by stringent nuclear legislation which ensures at least an equivalent level of safety.

The aim of the regulations is to prevent or mitigate the consequences of major accidents. A major accident could involve an uncontrolled release, fire or explosion that has serious consequences for human health or the environment. A major accident to the environment (MATTE) would cause severe and/or long term damage to the built or natural environment. In England we share the responsibility for enforcing COMAH on nuclear licensed sites with the Office for Nuclear Regulation (ONR) working as a joint competent authority. The ONR takes the lead on the safety issues and we take the lead on environmental aspects. Further information can be found at www.hse.gov.uk/COMAH.

7.1. Assessment objectives

Our assessment for this area was aimed at:

- deciding whether the UK ABWR would be a COMAH establishment
- deciding whether the UK ABWR design included measures to prevent a MATTE if COMAH was applicable

7.2. Hitachi-GE documentation

Hitachi-GE provided the information required by the P&ID in Section 8 of the 'Other Environmental Regulations' document (Hitachi-GE, 2017). This was split into 8 parts:

- Introduction (Section 8.1)
- P&ID requirements (Section 8.2)
- Regulatory context (Section 8.3)
- Background to COMAH (Section 8.4)
- Chemical inventory (Section 8.5)
- COMAH assessment findings (Section 8.6)
- Measures to prevent a MATTE (Section 8.7)

7.3. Assessment

7.3.1. Chemical inventory

Hitachi-GE presented a summary table identifying those chemicals used on the UK ABWR that are relevant to the COMAH Regulations. The table split the chemicals into those used during operations and those used in commissioning/decommissioning.

Hitachi-GE states that the quantity of each chemical stored on the UK ABWR has not been fixed at the GDA stage as the quantities stored on site are typically operational issues.

The following approach has been undertaken to determine the quantities of chemicals stored at the GDA stage.

Where the storage capacity of a container (tank/cylinder) for a chemical has been fixed, this has been used as the quantity to be stored in the COMAH assessment.

Where the storage capacity of a container is not fixed but the safety case sets a quantity of a chemical to be stored, then this quantity has been used in the COMAH assessment.

Where the storage capacity of a container is not fixed, and there is no specific safety case requirement, but there is information on the usage of a specific chemical (as determined by the operation of the UK ABWR), then Hitachi-GE have assumed that 7 days' supply for that chemical is taken to be stored on-site for the COMAH assessment.

Where there is no information available on the quantity of chemicals stored and there is no safety case requirement or usage figure, then no COMAH assessment has been made. It is expected that these chemicals will be addressed at the site-specific stage and we accept this approach for GDA.

Table 6. Summary of chemicals used on the UK ABWR that are relevant to the COMAH Regulations

Chemical	Quantity	Relevant to COMAH Regulations	COMAH Threshold (tonnes)	
			LT	UT
Chemicals stored on a UK ABWR for use in operation				
Acetylene (for cutting construction and maintenance	No information, not possible to determine at GDA stage	Named substance	5	50
Hydrogen (cooling for generator)	18 Nm^3/day, 11.3 kg for 7 days	Named substance	5	50
Hydrogen (for injection into feed-water for corrosion control)	307 Nm^3/day, 191 kg for 7 days			
Oxygen (for maintaining oxide coating in condensate piping)	160 l/hour, not possible to determine bulk storage at GDA stage	Named substance	200	2,000
Oxygen (for recombining excess hydrogen during hydrogen injection)	389 Nm^3/day (as gas) (equivalent to 556 kg) Storage requirement based on Japanese ABWR is 20 m^3 equivalent to 22.8 tonnes			
Diesel and light oil		Named substance (petroleum product)	2,500	25,000
Diesel (for use in generators and boilers)	2,863 m^3 for 7 days equivalent to 2,419 tonnes			
Light oil (for weekly maintenance assumed to be diesel)	525 litres storage capacity (0.44 tonnes)			

Chemical	Quantity	Relevant to COMAH Regulations	COMAH Threshold (tonnes)	
			LT	UT
Hydrazine (oxygen scavenger in auxiliary boiler system)	25 kg/year (0.48 kg for 7 days)	Named substance	0.5	2
Sodium nitrite (anti rust agent)	500 kg/year, 9.52 kg for 7 days	H1 Health Hazard	5	20
Ethylene glycol (antifreeze)	1.2 m^3/y, 0.023 m^3 for 7 days (0.025 tonnes)	H3 Health Hazard	50	200
Chemicals stored on a UK ABWR for use in commissioning/decommissioning				
Hydrazine (chemical decontamination during decommissioning)	3,200 litres (16 x 200 litres drums) 3.15 tonnes	Named substance	0.5	2
Sodium nitrite (anti rust agent)	1.1 tonnes at initial	H1 Health Hazard	5	20

Note: The named substance categorisation for hydrazine only applies if the hydrazine is present at a concentration above 5% by weight. The storage concentration for hydrazine will be determined at the site-specific stage, therefore, for GDA a concentration above 5% by weight has been assumed as a worst case (application of the lowest threshold).

7.3.2. Findings of COMAH assessment

The main chemicals relevant to COMAH that are used on the UK ABWR are summarised in the table below and compared against the COMAH qualifying thresholds.

Table 7. The findings of the COMAH assessment

Chemical	Stored quantity (tonnes)	Lower tier threshold (tonnes)	Upper tier threshold (tonnes)
Chemicals to be used on the UK ABWR during operation			
Diesel	2,419	2,500	25,000
Chemicals to be used on the UK ABWR during commissioning/decommissioning			
Hydrazine	3.15	0.5	2

Hitachi-GE states that the UK ABWR will be an upper tier COMAH establishment but only when decommissioning is carried out. This is because the quantity of hydrazine stored (3.15 tonnes) exceeds the upper tier qualifying threshold of 2 tonnes. The hydrazine is used as a chemical decontaminant. Significantly lower levels of hydrazine (25 kg/year) are used during operations as an oxygen scavenger for the auxiliary boilers.

The UK ABWR will not be a COMAH establishment during operation, as the amount of diesel (2,419 tonnes) stored is below the lower tier qualifying threshold of 2,500 tonnes. The quantity of diesel is based on 7 days' supply for the auxiliary boilers, EDGs, BBGs and the DAG.

It should be noted for the purposes of GDA that the generic site is based on a single reactor unit only and the likelihood is that any operational site will have at least 2 reactor units. This means that an operational site would be likely to be classed as a lower tier establishment during its operational phase.

As well as comparing individual named substances against the qualifying thresholds, operators are also required to carry out an assessment of all substances with the same generic hazard classification, added together, to determine whether COMAH applies. This assessment utilises a sum of fractions approach.

Hitachi-GE has carried out an aggregation assessment on the quantities of all known chemicals to be stored against the qualifying thresholds of the relevant generic categories of dangerous substances. This assessment did not alter the COMAH status initially identified.

At the site-specific stage a future operator will need to identify all the chemicals that will be used along with their storage quantities and carry out an assessment against the COMAH qualifying thresholds. This will be undertaken as part of future normal regulatory business.

Operators of upper tier establishments need to notify the competent authority and prepare a safety report. Where an establishment is already operational and falls under the COMAH Regulations due to an increase in the quantity of a chemical already used on-site, this should be done 3 months prior to the increased quantity being brought onto site.

The operator will also need to demonstrate to the competent authority that all measures necessary have been taken to prevent major accidents and limit their consequences to people or the environment. The notification, safety report and demonstration are site-specific issues for the operator and have not been considered further during GDA.

7.3.3. Measures to prevent a MATTE

Hitachi-GE states that the UK ABWR will have measures in place to avoid the release of hydrazine to the environment and prevent a MATTE.

Pollution prevention measures will include:

- storage of hydrazine in suitable containers (drums/IBCs) within buildings where possible
- all containers will be stored within suitable secondary containment systems (bunds or drip trays) which are impermeable to water and attack from hydrazine
- all secondary containment systems will be suitably sized to ensure that any spillages are contained

These prevention measures are in-line with relevant good practice and we will expect them to be implemented on any operational site.

The relatively low levels of hydrazine stored and the immediate dilution with cooling water means that the impact of any spillage to sea would be limited. We accept that the likelihood of any MATTE from an accident involving hydrazine is minimal.

Hitachi-GE has also included information on the primary, secondary and tertiary containment measures in place to prevent a MATTE from the bulk storage of diesel oil. This is because a slight increase in the quantity of diesel oil stored on-site (approximately 80 tonnes) would bring the UK ABWR into COMAH as a lower tier establishment.

Secondary containment measures include ensuring bund capacities are 110% of largest tank or 25% of the overall tank rated capacity, whichever is greater; walls, joints and floors being impervious to hydrocarbons; walls being capable of withstanding the hydrostatic pressures from a catastrophic tank failure; and concerete bunds being constructed with reinforced floors and walls to the required standards.

Tertiary containment measures will include passive in-situ engineered containment systems (bunds/lagoons) with active measurres such as remotely operated shut-off valves. The final design of the tertiary containment will be a site-specific issue depending on the site layout.

Hitachi-GE has stated that the secondary and tertiary containment systems will be in accordance with the requirements of the COMAH Competent Authority Policy for the Bulk Storage of Hazardous Liquids (COMAH Competent Authority, 2008) and associated guidance (COMAH Competent Authority, 2009). A future operator storing diesel oil above the COMAH threshold will be expected to comply with the COMAH Containment Policy.

We accept, for the purposes of GDA, that the UK ABWR design includes appropriate measures to prevent a MATTE.

7.4. Conclusion

Following the assessment of substances relevant to COMAH we conclude that:

- the UK ABWR will be a COMAH upper tier establishment during decommissioning based on the storage of more than 2 tonnes of hydrazine and the assumption, under worse case, that the hydrazine concentration is more than 5% by weight the UK ABWR will not be a COMAH establishment during operations although the level of diesel oil stored on-site is only just below the lower tier threshold
- the generic site used for GDA is based on one reactor unit and the likelihood is that most operational sites will have 2 reactor units and, will therefore, be a lower tier COMAH establishment during the operational phase
- the pollution prevention measures to be implemented on the UK ABWR along with the high cooling water dilution levels means a MATTE is highly unlikely from an accident involving hydrazine
- a future operator should be able to demonstrate that all measures necessary to prevent major accidents and limit their consequences to people and the environment have been taken for a UK ABWR

8. Compliance with Environment Agency requirements

Table 8. Compliance with Environment Agency requirements

P&ID Table 1 Section	Compliance comments
Section 8) Water use and abstraction	Information has been provided on fresh water requirements. Information has been provided on cooling water requirements. There is no information on the design of the abstraction inlet and outlets or fish deterrent systems although we accept this can only be decided at the site-specific stage.
Section 8) Discharges to surface water	The different aqueous waste streams have been identified. Information on the types and levels of contaminants in the various aqueous streams has been provided, except for HCW where there is minimal information on likely contaminants. Information has been provided on the treatment of the different effluent streams. A H1 impact assessment has been made on the discharges of iron to coastal waters. Semi-quantitative impact assessment has been carried out on other identified contaminants in the various aqueous waste streams. There is limited information on the contaminants in some of the waste streams, particularly the HCW. The impact of thermal discharges has been agreed to be out of scope of GDA due to the need for site-specific data to carry out the assessment. While we are likely to be able to grant an environmental permit for a water discharge activity, detailed information would be required at site-specific stage on the contaminants present in various waste streams.
Section 8) Discharges to groundwater	A statement has been provided that for the purposes of GDA there will be no discharges to groundwater. Measures to prevent accidental spills to land and groundwater have been provided.
Section 8) Operation of installations (combustion plant and incinerators)	The relevant combustion plant has been identified and a comparison has been made against the combustion sector guidance. The approach to monitoring greenhouse gases has been outlined. A statement has been provided that for GDA purposes there will be no on-site incineration of waste.

P&ID Table 1 Section	Compliance comments
Section 8) Substances subject to the Control of Major Accident Hazards Regulations	An assessment has been made of substances known to be stored on site against the qualifying thresholds in the COMAH 2015 Regulations. Measures to prevent a major accident to the environment have been described.

9. Public comments

We held a public consultation on our preliminary GDA assessment findings (Environment Agency, 2016c, which ran for 12 weeks, from 12 December 2016 to 3 March 2017. We received a number of consultation responses, all of which have been published in full for everyone to view (Environment Agency, 2017b). Our replies to each point raised are presented within our decision document (Environment Agency, 2017c). Points raised that were in GDA scope and relevant to other environmental regulations are summarised below:

We received a comment (ABWR-09h) regarding the recovery of low grade heat particularly through the use of a hybrid cooling system and the use of electro-chlorinators to create biocidal cooling water. For the purposes of the GDA the design is based on once-through cooling for the generic site and we accept this as BAT for a coastal site. At the site-specific stage, a future operator will need to demonstrate that the chosen cooling system represents BAT. We acknowledge that for an estuarine site that alternative cooling systems, for example hybrid cooling, may be considered as BAT.

We received a comment ((ABWR-09i) relating to 'Operation of installations' and the scope of application across the nuclear power plant. For the purposes of GDA, the 'Operation of installations' covers the non-nuclear combustion plant (diesel generators and auxiliary boilers) that provide back-up electricity and conventionally generated steam. The GDA process assesses whether the combustion plant requires an installation environmental permit under the Environmental Permitting Regulations and if so whether we are likely to grant a permit based on the environmental impact from the combustion plant provided site-specific assessment was deemed appropriate. The installation environmental permit is a separate permit to the radioactive substances environmental permit and both would be required by an operator at the site-specific stage, along with a nuclear site licence, which would be issued by the ONR. Radioactive emissions associated with the reactors and steam turbines along with maintenance of these facilities would be covered by the radioactive substances permit (and nuclear site licence). Emissions from the combustion plant and maintenance of the equipment would be covered by the Installations environmental permit. A future operator would have to apply for both permits at the site-specific stage and we would only issue the permits if the management arrangements and environmental impacts were acceptable.

We received a comment (ABWR-09i) querying as to why diesel fuel was considered BAT for the auxiliary boilers and emergency generators when lower emission alternatives such as natural gas were available. The auxiliary boilers and emergency generators are required for nuclear safety and need to respond when called upon. One of the key considerations is the availability of supply in emergency situations, and on-site diesel fuel storage provides a more robust supply when compared to natural gas supply. The final choice of the fuel for the auxiliary boilers and emergency generators is a site-specific issue and is for a future operator to decide taking into consideration nuclear safety requirements.

We received a comment (ABWR-09j) asking when COMAH would apply for a site applying for two reactor units. This is a site-specific issue and is out of scope of GDA. It should be noted, however, that COMAH applies once the amount of the dangerous substance exceeds the relevant qualifying threshold. For diesel oil, based on the information provided during the GDA, this would be when the fuel was brought on site for the second reactor. If two or more reactors were planned, we would expect a prudent operator to notify us at the site-specific permit application stage that they expect to be subject to COMAH Regulations.

We received a comment (ABWR-15d) noting that the plans for the auxiliary boilers and emergency diesel generators at Wylfa Newydd have considerably larger thermal outputs and that any changes are fed to the regulators at the earliest opportunity. This is a site-specific issue and is out of scope of GDA. It should be noted, however, that the auxiliary boilers and emergency diesel generators form the main combustion plant for the UK ABWR. A future operator will need to apply for an installations environmental permit to operate the combustion plant. As part of the permit application a future operator would need to identify the thermal input of the combustion plant and also demonstrate that the environmental impact from the combustion plant was acceptable. This process ensures that any changes from the combustion plant design covered by the GDA are captured and assessed.

We received a comment (ABWR-25d) stating that in relation to COMAH adequate emergency teams should be available on site at all times. This is a site-specific issue and is out of scope of GDA. It should be noted, however, that emergency preparedness is one of the key strategic topics for the COMAH Competent Authority and any future operator would be assessed for the adequacy of their emergency response arrangements.

We received a comment (ABWR-35e) from Public Health England noting that potential health implications relating to water abstraction were not considered. The GDA process requires the requesting party to identify the fresh water and cooling water requirements for the design and determine whether any permit or consent for water abstraction is required. Should a future operator require a permit for water abstraction it is at this permit application stage that any health implications would be considered.

10. Conclusion

We have concluded following the assessment of the other environmental regulations applicable to the UK ABWR that for:

Water use and abstraction

- an abstraction licence is not likely to be required for the UK ABWR as the cooling water is taken directly from the open sea and the fresh water is supplied directly by the local water company
- the choice of once-through seawater cooling is considered appropriate for the UK ABWR
- the final design of the abstraction intake and fish deterrent and return systems for the UK ABWR to minimise fish ingress and injury and meet the requirements of the Eels (England and Wales) Regulations 2009 (GB Parliament, 2009) is a site-specific issue and can only be determined once the local environmental conditions are known

Discharges to surface water

- the UK ABWR will have non-radioactive discharges to surface water and will require an environmental permit for a water discharge activity
- the UK ABWR could be granted a permit under The Environmental Permitting (England and Wales) Regulations 2010 for discharges to surface water, providing site-specific assessment was deemed acceptable. However, any future operator will need to provide more detailed information on the volumes and composition of the various aqueous waste streams and demonstrate that the environmental impact from the discharges is acceptable

Discharges to groundwater

- there should be no intentional discharges to groundwater and an environmental permit for a groundwater activity will not be required
- the UK ABWR should have appropriate measures in place to prevent pollution of the land or groundwater

Operation of installations (combustion plant and incinerators)

- the UK ABWR combustion plant (diesel generators and auxiliary boilers) will be a Part A(1) installation as described in Section 1.1 of Chapter 1 in Part 2 of Schedule 1 of The Environmental Permitting (England and Wales) Regulations 2010 and will require an environmental permit from the Environment Agency
- in principle we should be able to issue a permit under The Environmental Permitting (England and Wales) Regulations 2010 for the operation of the combustion plant, but any application for a permit will need:
    - a BAT assessment for the chosen diesel generators and auxiliary boilers
    - to demonstrate that the auxiliary boilers comply with the ELVs for medium combustion plants
    - site-specific modelling to demonstrate compliance with air quality objectives
- the UK ABWR combustion plant will require a permit under the Greenhouse Gas Emissions Trading Scheme Regulations 2012

Control of Major Accident Hazards Regulations

- the UK ABWR will be a COMAH upper tier establishment during decommissioning based on the storage of more than 2 tonnes of hydrazine and the assumption, under worse case, that the hydrazine concentration is more than 5% by weight
- A single UK ABWR, as assessed for GDA, will not be a COMAH establishment during operations although the level of diesel oil stored on site is only just below the lower tier threshold
- the generic site used for GDA is based on one reactor unit and the likelihood is that most operational sites will have 2 reactor units and will, therefore, be expected to be a lower tier COMAH establishment during the operational phase
- the pollution prevention measures to be implemented on the UK ABWR along with the high cooling water dilution levels means a MATTE is highly unlikely from an accident involving hydrazine
- a future operator should be able to demonstrate that all measures necessary to prevent major accidents and limit their consequences to people and the environment have been taken for a UK ABWR

References

Author	Reference
COMAH Competent Authority, 2008	Containment of Bulk Hazardous Liquids at COMAH Establishments.
COMAH Competent Authority, 2009	Containment of Bulk Hazardous Liquids at COMAH Establishments – Containment Policy Supporting Guidance for Secondary and Tertiary Containment.
EU, 2001	Integrated Pollution Prevention and Control (IPPC) Reference Document on the application of Best Available Techniques to Industrial Cooling Systems (European Commission, December 2001). http://eippcb.jrc.ec.europa.eu/reference/cv.html
EU, 2008	European Parliament and Council of the European Union, 2008. Directive on environmental quality standards in the field of water policy (2008/105/EC). Official Journal of the European Union, L 348, 84 – 97. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:348:0084:0097:EN:PDF
EU, 2012	The Monitoring and Reporting Regulation – General guidance for installations, MRR Guidance document No. 1, (European Commission, Version of 16 July 2012. https://www.gov.uk/.../uploads/.../6423-general-guidance-for-installations-mrr-g.pdf
Environment Agency, 2009	How to comply with your environmental permit - Additional guidance for combustion activities (EPR1.01) (Environment Agency, 2009). https://www.gov.uk/government/uploads/system/uploads/.../geho0209bpin-e-e.pdf
Environment Agency, 2010	Cooling Water Options for the New Generation of Nuclear Power Stations in the UK (Science Report: SC070015/SR3, Environment Agency, 2010). https://www.gov.uk/government/uploads/system/uploads/.../scho0610bsot-e-e.pdf
Environment Agency, 2011a	Chemical discharges from nuclear power stations: historical releases and implications for Best Available Techniques (Science Report: SC090012/R1, Environment Agency, 2011). https://www.gov.uk/government/uploads/system/uploads/.../scho0911bubz-e-e.pdf

Author	Reference
Environment Agency, 2011b	Horizontal Guidance Note H1 Annex D, Basic Surface water discharges (Environment Agency, version 2.2, 2011.
Environment Agency, 2011c	Horizontal Guidance Note H1 Annex F, Air Emissions (Environment Agency, version 2.2, 2011).
Environment Agency, 2013a	Process and information document for generic assessment of candidate nuclear power plant Designs (Environment Agency, version 2, March 2013). http://webarchive.nationalarchives.gov.uk/20151009003754/https://www.gov.uk/government/publications/assessment-of-candidate-nuclear-power-plant-designs
Environment Agency, 2013b	How to comply with your environmental permit, Environment Agency, version 6, June 2013.
Environment Agency, 2016	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE Nuclear Energy Limited's UK Advanced Boiling Water Reactor. Consultation document. LIT10603, December 2016. https://www.gov.uk/government/consultations/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor
Environment Agency, 2017a	Generic design assessment for new nuclear power plant: assessment of aqueous radioactive waste for Hitachi-GE UK ABWR design. AR05
Environment Agency, 2017b	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE Nuclear Energy Limited's UK Advanced Boiling Water Reactor. Responses to GDA consultation for the UK ABWR. LIT10656, July 2017. https://www.gov.uk/government/consultations/gda-of-hitachi-ge-nuclear-energy-ltds-uk-advanced-boiling-water-reactor
Environment Agency, 2017c	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE Nuclear Energy Limited's UK Advanced Boiling Water Reactor. Decision Document. LIT10714.
GB Parliament, 1999	The Control of Major Accident Hazards Regulations 1999, SI 1999 No. 743, as Amended. http://www.legislation.gov.uk/uksi/1999/743/contents/made
GB Parliament, 2009	The Eels (England and Wales) Regulations 2009, (SI 2009 No. 3344). http://www.legislation.gov.uk/uksi/2009/3344/contents/made
GB Parliament, 2012	The Greenhouse Gas Emission Trading Scheme Regulations 2012. www.legislation.gov.uk/uksi/2012/3038/pdfs/uksi_20123038_en.pdf

Author	Reference
GB Parliament, 2015	The Control of Major Accident Hazard Regulations 2015, (SI 2015 No. 483). http://www.legislation.gov.uk/uksi/2015/483/contents/made
GB Parliament, 2016	The Environmental Permitting (England and Wales) Regulations 2016, (SI 2016 No. 1154 http://www.legislation.gov.uk/uksi/2016/1154/contents/made
Hitachi-GE, 2017	Other Environmental Regulations, GA-9901-0027-00001, Revision G
IAEA, 2001	Handling and Processing Radioactive Waste from Nuclear Applications Technical Report Series No. 402, International Atomic Energy Agency, Vienna 2001. www.pub.iaea.org/MTCD/Publications/PDF/TRS402_scr.pdf

List of abbreviations

Abbreviation	Details
ABWR	Advanced Boiling Water Reactor
BAT	best available techniques
BBGs	back-up building generators
CAD	controlled area drain
CO	carbon monoxide
COD	chemical oxygen demand
COMAH	Control of Major Accident Hazards
CW	circulating water
DAG	diverse additional generator
DC	discharge concentration
DF	decontamination factor
EC	European Commission
EDG(s)	emergency diesel generator(s)
ELVs	emission limit values
GDA	generic design assessment
GEP	generic environmental permit
HCW	high chemical impurities waste
IAEA	International Atomic Energy Authority
LCW	low chemical impurities waste
LD	laundry drain
MATTE	major accident to the environment

Abbreviation	Details
MW	megawatt
NOEC	no observed effect concentration
NOx	oxides of nitrogen
NSD	non-radioactive storm drain
P&ID	process and information document
PC	process contribution
PM	particulate matter
ppb	parts per billion
ppm	parts per million
PWTF	purified water treatment facility
RCW	reactor clean up water
RSW	reactor building service water
SO2	sulphur dioxide
SWSD	service water storm drain
TCW	turbine building cooling water
TOC	total organic carbon
TRO	total residual oxidant
TSW	turbine building service water
USEPA	United States Environmental Protection Agency

National Resources Wales Customer Care Centre 0300 065 3000 (Mon-Fri, 9am-5pm)

Our Customer Care Centre handles everything from straightforward general enquiries to more complex questions about registering for various permits.

Email

enquiries@naturalresourceswales.gov.uk

By post

Natural Resources Wales
c/o Customer Care Centre
Ty Cambria
29 Newport Rd
Cardiff
CF24 0TP

Incident Hotline 0800 80 70 60 (24 hour service)

You should use the Incident Hotline to report incidents such as pollution. You can see a full list of the incidents we deal with on our ‘Report an incident' page.

Floodline 0345 988 1188 (24 hour service)

Contact Floodline for information about flooding.
Floodline Type Talk: 0345 602 6340 (for hard of hearing customers).

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

Then call us on
03708 506 506 (Monday to Friday, 8am to 6pm)

email
enquiries@environment-agency.gov.uk

or visit our website
www.gov.uk/environment-agency

incident hotline 0800 807060 (24 hours)
floodline 0345 988 1188 (24 hours)

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

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

LIT10725