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 - AR02 Strategic waste management

12 December 2016

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Executive summary

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

Process and Information Document[1]	The following sections of Table 1 in our process and information document (P&ID) are relevant to this assessment: Item 4: specifically 'Identification of the strategic considerations with respect to radioactive waste management which underpin the design.'

Radioactive Substances Regulation Environmental Principles[2]	The following principles are relevant to this assessment: RSMDP1 - Radioactive substances strategy RSMDP3 - Use of BAT to minimise waste DEDP1 – Decommissioning strategy DEDP2 – Decommissioning plan DEDP3 – Considering decommissioning during design and operation

Report author	Gary McMeekan

This report presents the findings of our detailed assessment of the integrated waste strategy (IWS) that supports Hitachi-GE's proposed UK Advanced Boiling Water Reactor (UK ABWR). An IWS should:

- be concise, strategic and a communication tool, with a focus on how wastes will be managed now and over the site lifetime
- set out what challenges lie ahead and when they need to be addressed

We have concluded that:

- Hitachi-GE has provided an acceptable waste strategy for all waste streams that a UK ABWR will typically produce. The details underpinning the IWS in this respect are considered in

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

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

greater detail in our relevant assessment reports for individual waste streams and disposability (Environment Agency, 2016a, 2016b, 2016c and 2016d).

- Hitachi-GE's IWS, in conjunction with its other submissions, will help to optimally protect human health and the environment. The details underpinning the IWS in this respect are considered in greater detail in our relevant assessment reports on radiological assessments to people and the environment (Environment Agency, 2016e and 2016f).
- The IWS is consistent with recent government policy statements (DECC, 2014) and current regulatory expectations.

We further conclude that we require further detailed evidence on how the UK ABWR is designed to facilitate decommissioning, minimise decommissioning waste and minimise the impacts on people and the environment from decommissioning operations. We have identified a potential GDA Issue that reflects this conclusion.

We will continue to review these conclusions as Hitachi-GE's design for the UK ABWR develops and our assessment progresses.

Contents

1. Introduction

Guidance on our generic design assessment (GDA) process was published in March 2013 (process and information document (P&ID), version 2 (Environment Agency, 2013). Table 1, Item 4 of the P&ID requires the requesting parties (RPs), among other things, to:

- identify the strategic considerations with respect to radioactive waste management which underpin the design
- describe how radioactive wastes and spent fuel will arise throughout the facility's lifecycle (including decommissioning) and plans for how they will be managed to encompass:
    - sources of radioactivity and matters which affect wastes arising
    - gaseous, aqueous and other wastes

We expect new nuclear power plant designs to be developed in line with a radioactive waste and spent fuel strategy that seeks to:

- minimise the production of radioactive waste
- manage unavoidable wastes and spent fuel so as to achieve an optimal level of protection for people and the environment

Our radioactive substances regulation environmental principles (REPs) (Environment Agency, 2010) set out the matters that this type of strategy should take into account. For new nuclear power plant designs, the strategy also needs to be consistent with recent government policy statements (DECC, 2014) that:

- the disposal of intermediate level radioactive waste (ILW) to a future geological repository, from any new nuclear power stations, is unlikely to occur until late this century
- any nuclear power stations that might be built in the UK should proceed on the basis that spent fuel will not be reprocessed

For decommissioning, in line with government policy (DECC, 2009b), we expect:

- The radioactive waste and spent fuel strategy to address decommissioning
- The design to use the best available techniques (BAT) to:
    - facilitate decommissioning
    - minimise arisings of decommissioning waste
    - minimise the impacts on people and the environment of decommissioning operations and the management of decommissioning waste

We carry out our assessment in two stages:

- Preliminary assessment – we examine the outline details of the RP's submission to find out if further information is needed, if there are any issues that are obviously unacceptable, or if there needs to be any significant design modifications.
- Detailed assessment – we examine the submission in detail to decide initially if we might issue a statement of design acceptability. We will only make our final decision after we have consulted the public and considered the responses we receive.

Hitachi-GE submitted its UK ABWR design for GDA in April 2014. We published the findings of our preliminary assessment in August 2014 (Environment Agency, 2014). The documents that make

up the GDA submission are hosted on Hitachi-GE's website http://www.hitachi-hgne-uk-abwr.co.uk/gda_library.html.

2. Assessment

2.1. Assessment methodology and process

The basis of our assessment was to:

- examine and gain understanding of the IWS and its supporting documents
- hold technical meetings with Hitachi-GE, the RP, to clarify and improve our understanding of the information presented and to identify and explain any concerns that we had with that information
- raise Regulatory Observations (ROs) and Regulatory Queries (RQs) where we believed information provided by the requesting party was insufficient or required clarification, although none were raised relating to the IWS
- assess the IWS provided by the RP using our internal guidance and regulatory experience and decide if the chosen strategy will minimise the production of radioactive waste and manage unavoidable wastes so as to achieve an optimal level of protection for people and the environment
- decide on any GDA Issues or assessment findings to carry forward from GDA

2.2. Assessment objectives

We started our assessment with three key questions:

- Does the IWS likely cover all waste streams that a UK ABWR would typically produce?
    - The details underpinning the IWS in this respect are considered in greater detail in our relevant assessment reports for individual waste streams and disposability (Environment Agency, 2016a, 2016b, 2016c and 2016d)
- Will the IWS help to optimally protect human health and the environment?
    - The details underpinning the IWS in this respect are considered in greater detail in our relevant assessment reports on radiological assessments to people and the environment (Environment Agency, 2016e and 2016f)
- Is the IWS consistent with government policy, regulatory expectations and current industry good practice?

2.3. Assessment limitations and scope

Any 'strategy' that relates to how aspects of a nuclear facility should be operated which is included in a submission for GDA has limitations where the submission relates to a 'generic site' and does not identify a future operator of that site. In the case of waste management, there are two main areas where the information submitted for GDA is – by necessity – likely to be less detailed than that we would expect for an operational facility.

Firstly, proximity of disposal: as the submission for GDA relates to a 'generic site' it could never be clear where the most suitable disposal facility for a given waste stream is relative to the UK ABWR in geographical terms. For example, for low level radioactive waste (LLW), it is possible that a suitable disposal facility may be located closer to the eventual site than the Low Level Waste Repository (LLWR) near Drigg in Cumbria. Secondly, there are commercial factors which may influence the choice of disposal route for a particular waste and questions like "does the eventual

operator have multiple, similar plants?", "are there economies of scale to be considered in a holistic demonstration of BAT?", "could the eventual operator enter into a commercial arrangement to secure more proximate disposal?" and so on have to be considered. Clearly for a 'generic site' for GDA, it would be unreasonable for regulators to expect these issues to be fully resolved. Therefore, we consider this to be two distinct assessment findings.

Assessment Finding 1: A future UK ABWR operator shall provide details of how the proximity principle has been applied in its demonstration of BAT for solid and incinerable liquid wastes before it starts active commissioning of the UK ABWR.

Assessment Finding 2: If appropriate, a future site operator shall produce an assessment of BAT which covers all of its sites, noting economies of scale and other efficiencies in disposal of solid and incinerable liquid wastes across all of its sites before it starts active commissioning of the UK ABWR.

We have undertaken a detailed review of the RP's IWS and the documents that support it. The purpose of an IWS is to set the strategy for how wastes will be managed at all stages of a nuclear power station's "life", from construction, to operation and then to final decommissioning.

The IWS sets out, in broad 'strategic'; terms, how the RP intends to comply with legal obligations and industry good practice as they relate to waste management. The strategy gives consideration to the requirements of environmental legislation such as the Environmental Permitting Regulations 2010 (as amended) and industry good practice, such as the application of the waste hierarchy.

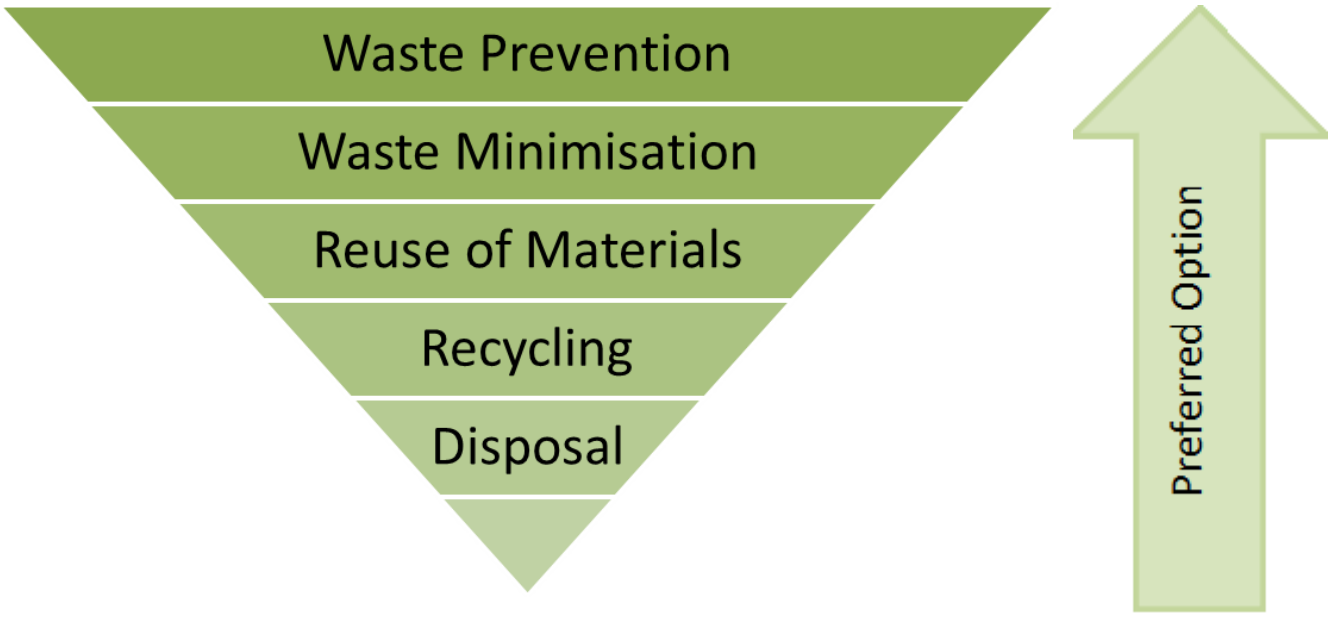

Figure 1. Schematic representation of the waste hierarchy

2.4. Hitachi-GE documentation

We reviewed the following documents to produce this report (Table 1):

Table 1. Hitachi-GE documents reviewed in this assessment

Document Reference	Title
GA91-9101-0101-18002_Rev B	Generic PCSR Subchapter 18.2: Liquid Radioactive Waste Management System.
GA91-9101-0101-18003_Rev B	Generic PCSR Subchapter 18.3: Off-Gas Radioactive Waste Management System.
GA91-9101-0101-18004_Rev B	Generic PCSR Subchapter 18.4: Solid Radioactive Waste Management System.
GA91-9101-0101-19000_Rev B	Generic PCSR Chapter 19: Fuel Storage and Handling.
GA91-9101-0101-32000_Rev B	Generic PCSR Chapter 32: Spent Fuel Interim Storage.
GA91-9101-0101-31000_Rev B	Generic PCSR Chapter 31: Decommissioning.
GA91-9201-0001-00173_Rev 3	Topic Report on Decommissioning: Decommissioning Waste Management.
GA91-9201-0003-00424_Rev 1	Radioactive Waste Management Case.
GA91-9201-0003-00425_Rev 2	Integrated Waste Strategy.
GA91-9901-0019-00001_Rev G	Summary of the Generic Environmental Permit Applications.
GA91-9901-0020-00001_Rev E	Generic Site Description.
GA91-9901-0022-00001_Rev G	Radioactive Waste Management Arrangements.

2.5. Integrated waste strategy

The RP's IWS outlines its current strategy for managing radioactive and non-radioactive waste, including spent fuel arising from the construction, operation and decommissioning of the UK ABWR. The strategy is supported by:

- radioactive waste management arrangements
- a decommissioning strategy
- methodologies to assess BAT and to define the approach to optimisation
- impact assessments for humans and wildlife

The IWS has been derived for a single reactor unit situated at a generic site. The extent of the strategy covers:

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

The spent fuel management strategy that has been adopted is not to reprocess but to store, package and appropriately dispose of when a disposal route becomes available which is consistent with the UK government 'base case' (DECC, 2011).

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

The IWS seeks to apply the concentrate and contain principle to individual radioactive waste streams, including the balance between liquid and gaseous discharges and the generation of solid waste streams. The 'concentrate and contain' option involves trapping the radioactivity in a solid, concentrated form for storage and eventual disposal rather than the 'dilute and disperse' option that involves the direct discharge of gaseous or liquid radioactivity into the environment (DECC, 2009a).

The UK government remains committed to the policy of geological disposal, for the reasons set out in Committee on Radioactive Waste Management (CoRWM) 'Managing Radioactive Waste Safely' (CoRWM, 2006) and subsequent UK government policy documents on radioactive waste management. The European Directive establishing a framework for the responsible and safe management of spent fuel and radioactive waste recognises that deep geological disposal represents the safest and most sustainable option as the end point of the management of high level waste and spent fuel considered as waste. The UK government continues to favour an approach to siting a geological disposal facility (GDF) that is based on the willingness of local communities to participate in the siting process. The UK government considered what lessons could be learned from the operation of the siting process since 2008. To support this consideration, the UK government conducted a 'Call for Evidence' in May 2013, to enable a wider range of stakeholders to input into its review. In June 2013, the current CoRWM issued a statement reiterating its commitment to geological disposal. The Welsh government has decided to adopt a policy for geological disposal for the long term management of higher activity radioactive waste (Welsh Government, 2015).

To take this into account, the Office for Nuclear Regulation (ONR), the Environment Agency and the Scottish Environment Protection Agency (SEPA) have developed a series of joint guidance documents on the management of higher activity radioactive waste (available at http://www.onr.org.uk/wastemanage.htm)[3]. These specify the production, content, maintenance and review of radioactive waste management cases (RWMCs). The RWMC should demonstrate the long-term safety and environmental performance of the management of higher activity radioactive waste from generation to conditioning into a form that will be suitable for storage and eventual disposal. The requesting party has made reference to its RWMC in the IWS.

Solid radioactive waste – which has been produced after application of the waste hierarchy and minimised using BAT – will be stored on site in dedicated buildings pending disposal at an appropriately permitted facility. In the case of lower activity wastes, disposal will be to an appropriately permitted facility as soon as is practicable. In the case of higher activity wastes, this will be to the geological disposal facility (GDF) once that is available which is consistent with recent government statements (DECC, 2014).

2.6. Matters specific to decommissioning

The IWS summarises the waste management strategy that should be employed when the UK ABWR is decommissioned. It acknowledges that the limits within an environmental permit during the decommissioning phase of a nuclear power station's 'life' are likely to be different to those in operation and suggests that an eventual operator takes note of this. It lists which systems will no

[3] This guidance has also been endorsed by Natural Resources Wales.

longer be required as soon as electricity generation ceases and identifies these as candidates for prompt decommissioning. It also lists the systems that the UK ABWR used during operation which will be critical to sustaining decommissioning activities – such as heating, ventilation and air conditioning (HVAC), liquid effluent systems and solid waste facilities.

A summary of estimates of waste volumes during decommissioning is provided in the IWS and these give both the eventual operator the ability to consider waste volumes and costs and make adequate provision for decommissioning well ahead of the task itself. The creation of both radioactive and non-radioactive liquid and gaseous waste streams is noted in the IWS but no attempt to quantify them has been made. We accept that these waste streams are unlikely to be readily quantifiable at this stage as much will depend on how the plant was operated.

Although only a summary of the decommissioning strategy is provided within the IWS, we have also reviewed Revision B of Chapter 31 of the pre-construction safety report (PCSR) where the details that implement the strategy are contained. We have also reviewed the RP's 'Radioactive Waste Management Arrangements' which provide greater detail on how decommissioning wastes will be managed (see Table 1).

With ONR, we have requested further information from Hitachi-GE on decommissioning for consideration in ONR's Step 4 assessmentRQ-ABWR-0825, RQ-ABWR-0826 RQ-ABWR-0827 and RQ-ABWR-0833). These requests are summarised in Table 2. We requested further detailed evidence to be provided in GDA on decommissioning to demonstrate that the UKABWR design has been optimised for decommissioning. We note that this would also assist any future operator in providing a decommissioning and waste management plan.

Table 2. Summary of regulatory queries relating to decommissioning.

RQ Number	Title	Further information requested
RQ-ABWR-0825	Optimisation of Future Commitments	Clarify how the design of the spent fuel pond will enable and not preclude future management options for size reducing the reactor pressure vessel. Provide evidence to show that the final batch of spent fuel can be transferred promptly from the spent fuel pond.
RQ-ABWR-0826	Decommissioning of Large Items	Systematically identify all large, heavy and contaminated items within the turbine building (T/B). Show that the design and operating mode of large items in the T/B will not pose a risk to decommissioning.
RQ-ABWR-0827	Decommissioning and the requirements of RO-ABWR-0057	Provide evidence that the requirements of RQ-ABWR-0057 (relating to probabilistic safety assessment) have been complied with, with respect to decommissioning.
RQ-ABWR-0833	Optimisation in Decommissioning	Provide evidence to show that the UKABWR design and operating philosophies have been systematically and comprehensively challenged, to identify all reasonably practicable improvements to optimise: the scale and difficulty of Decommissioning that will be required at the end of the station's operational life

RQ Number	Title	Further information requested
		incorporation of design features to enable the required Decommissioning activities to be carried out without unnecessary risks to safety and the environment Provide evidence to demonstrate how Relevant Good Practice has been identified and applied in the context of Decommissioning specifically with regard to the design of the UKABWR.

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

- TR 1: Decommissioning Strategy
- TR 2: Design for Decommissioning
- TR 3: Decommissioning Plan
- TR 4: Decommissioning Techniques
- TR 5: Construction Techniques
- TR 6: Decommissioning Waste Strategy
- TR 7: Decommissioning Assessment

As Hitachi-GE has yet to provide a complete case to demonstrate that the UK ABWR has been designed for decommissioning our conclusion is currently subject to the following potential GDA Issue:

Potential GDA Issue 1 – Decommissioning of the UK ABWR.

We require Hitachi-GE to: Provide sufficient evidence to demonstrate that the UK ABWR has been designed to facilitate decommissioning and hence to minimise associated waste and impacts on people and the environment from decommissioning operations.

The Hitachi-GE programme was such that not all documents were available for assessment at the time of our assessment deadline and that several of these are expected to be updated in September 2016 and December 2016. We will, therefore, consider these documents as part of our ongoing assessment and foresee that this potential GDA Issue may be resolved prior to the end of GDA.

2.7. Compliance with Environment Agency requirements

Table 3. Compliance with Environment Agency requirements.

P&ID Table 1 Section or REP	Compliance comments
Table 1, Item 4	Paragraphs 1 and 2 Compliant.
RSMDP1	Radioactive substances strategy

P&ID Table 1 Section or REP	Compliance comments
	Compliant.
RSMDP3	Use of Best Available Techniques to Minimise Waste Compliant
DEDP1	Decommissioning Strategy Compliant
DEDP2	Decommissioning Plan Compliant
DEDP3	Considering Decommissioning During Design and Operation Not-Compliant. We are not satisfied that sufficient evidence to demonstrate that the UK ABWR has been designed to facilitate decommissioning and hence to minimise associated waste and impacts on people and the environment from decommissioning operations was provided in Hitachi-GE's IWS or supporting documents. This has been raised as a potential GDA Issue and resolution is ongoing.

3. Public Comments

No comments were received up to 8 July 2016 concerning strategic management of waste.

4. Conclusion

We have concluded that:

- Hitachi-GE has provided an acceptable waste strategy for all waste streams that a UK ABWR will typically produce. The details underpinning the IWS in this respect are considered in greater detail in our relevant assessment reports for individual waste streams and disposability (Environment Agency, 2016a, 2016b, 2016c and 2016d).
- Hitachi-GE's IWS – in conjunction with its other submissions – will help to optimally protect human health and the environment. The details underpinning the IWS in this respect are considered in greater detail in our relevant assessment reports on radiological assessments to people and the environment (Environment Agency, 2016e and 2016f).
- The IWS is consistent with recent government policy statements (DECC, 2014) and current regulatory expectations.

We further conclude that we require further detailed evidence on how the UK ABWR is designed to facilitate decommissioning, minimise decommissioning waste and minimise the impacts on people and the environment from decommissioning operations. We have identified a potential GDA Issue that reflects this conclusion.

We will continue to review these conclusions as Hitachi-GE's design for the UK ABWR develops and our assessment progresses.

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Environment Agency, 2016c	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE Nuclear Electric Limited's UK Advanced Boiling Water Reactor. AR05, aqueous radioactive waste.
Environment Agency, 2016d	Assessing new nuclear power station designs. Generic design assessment of Hitachi-GE Nuclear Electric Limited's UK Advanced Boiling Water Reactor. AR06 Solid radioactive waste, spent fuel and disposability.
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List of abbreviations

Abbreviation	Details
ABWR	Advanced Boiling Water Reactor
BAT	Best available techniques
CoRWM	Committee on Radioactive Waste Management
GDA	Generic design assessment
GDF	Geological disposal facility
HVAC	Heating, ventilation and air conditioning
IWL	Intermediate level waste
IWS	Integrated waste strategy
LAW	Lower activity wastes
LLW	Low level waste
ONR	Office for Nuclear Regulation
P&ID	Process and information document
PCSR	Pre-construction Safety Report
REP	Regulation Environmental Principle
RI	Regulator Issue
RO	Regulatory Observation
RQ	Regulatory Query
RWMC	Radioactive waste management case
SEPA	Scottish Environment Protection Agency
TR	Topic report

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