

UK ABWR

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UK ABWR Generic Design Assessment

Generic Site Description



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1. Acronyms

ABWR	Advanced Boiling Water Reactor
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
EIA	Environmental Impact Assessment
ERICA	Environmental Risk from Ionising Contaminants: Assessment and Management
EU	European Union
GDA	Generic Design Assessment
GEP	Generic Environmental Permit
Hitachi-GE	Hitachi-GE Nuclear Energy, Ltd.
IRAT	Initial Radiological Assessment Tool
NHS	Non-human species
NPS	National Policy Statement
ONR	Office for Nuclear Regulation (UK)
P&ID	Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Design
PCSR	Pre-Construction Safety Report
REP	Radioactive Substances Regulation – Environmental Principles
SoDA	Statement of Design Acceptability
SSA	Strategic Siting Assessment
UK	United Kingdom

2. References

- [Ref-1] Environment Agency, “Process and Information Document for the Generic Assessment of Candidate Nuclear Power Plant Designs”, version 3, October 2016.
- [Ref-2] Environment Agency, “Radioactive Substances Regulation - Environmental Principles”, version 2, April 2010.
- [Ref-3] Hitachi-GE Nuclear Energy, Ltd., “Alignment with the REPs, GA91-9901-0028-00001”, XE-GD-0099, Rev F, August 2017.
- [Ref-4] Department of Energy & Climate Change, “National Policy Statement for Nuclear Power Generation (EN-6): volume II of II - Annexes”, July 2011.
- [Ref-5] Department of Energy & Climate Change, “National Policy Statement for Nuclear Power Generation (EN-6): volume I of II”, July 2011.
- [Ref-6] Hitachi-GE Nuclear Energy, Ltd., ”Generic PCSR Chapter 9: General Description of the Unit (Facility)”, GA91-9101-0101-09000, SE-GD-0136, Rev C, August 2017.
- [Ref-7] Hitachi-GE Nuclear Energy, Ltd., “Summary of the Generic Environmental Permit Application”, GA91-9901-0019-00001, XE-GD-0094, Rev H, August 2017.
- [Ref-8] Hitachi-GE Nuclear Energy, Ltd., “Genesis of ABWR design”, GA91-9901-0034-00001, XE-GD-0136, Rev A, October 2013.
- [Ref-9] National Radiological Protection Board, “A Model for Short and Medium Range Dispersion of Radionuclides Released to the Atmosphere”, R. H. Clarke (Chairman), NRPB-R91, Harwell, Oxon. 1979.
- [Ref-10] Environment Agency, Initial Radiological Assessment Methodology – Part 1 User Report, Science Report: SC030162/SR1, May 2006.
- [Ref-11] Environment Agency, Initial Radiological Assessment Methodology – Part 2 Methods and Input Data, Science Report: SC030162/SR2, May 2006.
- [Ref-12] Hitachi-GE Nuclear Energy, Ltd., “Prospective Dose Modelling”, GA91-9901-0026-00001, HE-GD-0005, Rev G, August 2017.
- [Ref-13] Norwegian Radiation Protection Authority, “UPDATES TO THE ERICA TOOL – VERSION RELEASED 2014”, November 2014.
- [Ref-14] National Radiological Protection Board, “Generalised habit data for radiological assessments”, Smith, K.R. and Jones, A.L., NRPB-W41, Harwell, Oxon. 2003.
- [Ref-15] Health Protection Agency, “The Methodology for Assessing the Radiological Consequences of Routine Releases of Radionuclides to the Environment Used in PC-CREAM 08”, J G Smith and J R Simmonds (Eds), HPA-RPD-058, November 2009.
- [Ref-16] Centre for Environment, Fisheries and Aquaculture Science, “Radiological Habits Surveys [for English and Welsh nuclear power stations] CEFAS 2008-2014”. (See footnote 1 for exact reports used).

3. Introduction

The Environment Agency has identified the information it requires to assess the environmental impacts of the UK ABWR, at a generic site in England or Wales, in its Process and Information Document for the Generic Assessment of Candidate Nuclear Power Plant Designs (P&ID) [Ref-1]. The P&ID requires that the characteristics of the generic site which have been used in the radiological dose assessments forming part of Hitachi-GE's Generic Design Assessment (GDA) submission are clearly identified. This document describes the generic site characteristics used in Hitachi-GE's radiological dose assessments, including short-term, annual and collective dose assessments to humans and dose assessments on non-human species (NHS).

The information on the generic site characteristics is provided to fulfil the P&ID requirement in order to allow the Environment Agency (and other interested parties) to determine the basis of Hitachi-GE's GDA submission, and carry out their own confirmatory radiological dose modelling or assessments, as required.

4. Regulatory Context

4.1. P&ID Requirements

The P&ID requirements relating to the description of the Generic Site Description are reproduced below:

'General information relating to the requesting party and the design.

Include:

Description and characteristics of the generic site (or sites) that the requesting party will use to provide its dose assessment. Any statement of acceptability we issue after our assessment will be on the basis of these characteristics. A range of generic sites might be chosen with coastal, estuarine and inland characteristics ([Ref-1], Table 1, Item 1, bullet 5).'

4.2. Consideration of REPs

Hitachi-GE's 'Alignment with the Radioactive Substances Regulation Environmental Principles' report [Ref-3] details the approach undertaken by Hitachi-GE to reviewing and taking account of each Radioactive Substances Regulation – Environmental Principles (REPs) [Ref-2] considered relevant to the requesting party's GDA submission.

SEDP5 - On-Going Evaluation has been identified by Hitachi-GE as a REP with relevance to the selection of a generic site as part of GDA.

4.3. Potential Sites for New Nuclear Build in England and Wales

The Government's Strategic Siting Assessment (SSA) of nominated sites, and the associated strategic level screening assessment for the identification of any alternative sites (the Alternative Sites Study), were designed and carried out to identify sites in England and Wales that are potentially suitable for the deployment of new nuclear power stations by the end of 2025. The assessment of the potential suitability of the sites took into account a number of social, environmental and operational factors [Ref-4].

The results of the SSA and the Alternative Sites Study were publically reported in the Government's National Policy Statement for Nuclear (NPS) [Ref-4] [Ref-5]; eight sites were identified as potentially suitable. All of the eight sites reported as potentially suitable in the NPS are located by the sea or large estuaries, near to existing nuclear sites.

5. Characteristics of the Generic Site

5.1. Justification for Selected Site Parameters

The generic site characteristics/parameters outlined in this report are limited to those used in the radiological dose assessment undertaken up until the conclusion of Step 3 of GDA, at which point the Environment Agency will begin its consultation on its GDA conclusions.

The majority of the parameters and datasets used to describe the generic site are taken from common publications or guidance and would be the same for any of the potential UK nuclear new build sites identified in the NPS [Ref-4] [Ref-5]. In some instances additional site-specific data has been used to augment datasets; in all cases the data used falls within the ranges seen at the identified potential sites. The specific instances, justification and impacts of using additional data are described in 5.3 below. In most cases it is likely that detailed environmental modelling will need to be undertaken by future site operators using entirely site-specific data as part of the site-specific permit application process.

The generic site used by Hitachi-GE and described in this document is considered to be representative of the sites in England and Wales potentially suitable for the deployment of new nuclear power stations by the end of 2025.

5.2. Generic Site Setting Overview

The layout of the UK ABWR nuclear power station as considered at GDA is shown in Figure 5.2-1 (this information is further described in Generic PCSR Chapter 9: General Description of the Unit (Facility)) [Ref-6]. An overview of the main components and operation of the UK ABWR is provided in the Summary of the Generic Environmental Permit Application [Ref-7] and further information can be found in the “Genesis of ABWR design” report of the GDA submission [Ref-8].

All potential nuclear new build sites in the UK are either located by the sea or large estuaries. The UK ABWR generic site is coastal and, for the purposes of GDA, the UK ABWR is assumed to be once-through sea-water cooled, drawing cooling water from the sea and returning it, some 12°C warmer, to the sea.

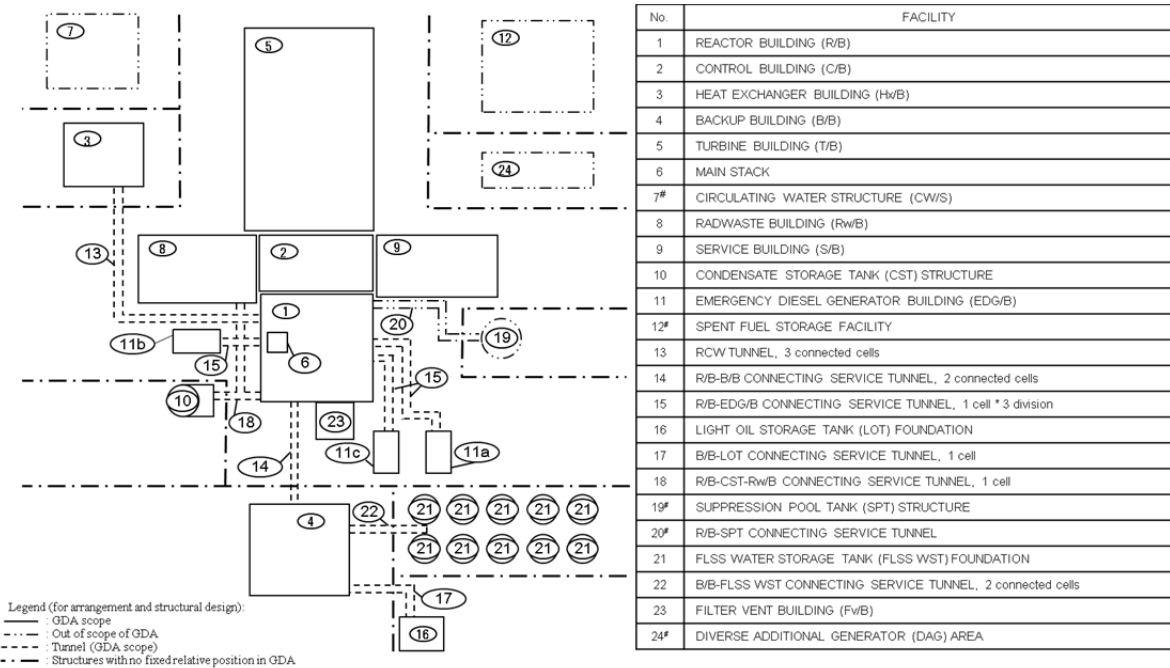
The geology at the generic site is assumed to be stable with no active faults. It should be noted that the seismic activity of potential sites is assessed by the Office for Nuclear Regulation (ONR); the effects of seismic activity on the UK ABWR design itself is not part of the GEP and is assessed elsewhere in the GDA submission as part of the PCSR.

The following general assumptions are also in place regarding the generic site:

- The site is not located on an aquifer from which water is extracted.
- There is no standing water at the site.
- There are no freshwater bodies or watercourses on the site.
- There are no discharges to rivers or streams on or adjacent to the site.
- There is no ground or groundwater contamination present.

The generic site and surrounding area is assumed to be a flat plain, with no large buildings, other than the UK ABWR nuclear power plant, in the immediate vicinity. Surface roughness (an air dispersion modeling parameter) is assumed to be 0.3m, a generic value typical of agricultural areas [Ref-9]. With all possible new build sites in the UK being adjacent to the sea or large estuaries, this surface roughness value is deemed to be representative at the GDA stage. The effects of neighbouring buildings and local terrain will be considered at the site-specific permitting stage.

Further specific characteristics of the site are provided in the following sections.



Note:

1. This drawing is only indicative. Final position of structures will be based on site location. Refer to each structural design report for the assumed size in GDA.
2. The civil engineering, i.e. general arrangement and structural design, of No 7, 12, 19, 20, 24 (shown with “#” in the table above) are NOT included in the GDA.

Figure 5.2-1: UK ABWR Power Station GDA Site Layout

5.3. Use of Additional Datasets

The parameters required for Stage 1 of the Environment Agency’s Initial Radiological Assessment Tool (IRAT) methodology use generic datasets, as dictated by the modelling packages referenced within the Environment Agency’s dose modelling guidance [Ref-10] [Ref-11]. For Stage 2 of the IRAT methodology, generic data sets are also used; however, in order to develop a more realistic assessment, site-specific data can be used to supplement the generic data. For the UK ABWR dose modelling, the local compartment volumetric exchange rate has been taken to be the volumetric exchange rate applicable to a site on the North Wales coast. This dataset is used because it is more representative of the dispersion in a location at which a UK ABWR may actually operate in future than the available generic data. For consistency with the data used in Stage 2 modelling, the Stage 3 radiological assessment defined the corresponding regional marine compartment as Irish Sea West.

As stated in section 5.1, the additional datasets used are within the range seen across all of the potential new build sites in England and Wales and do not represent extreme or unusual values. A comparison of each potential site’s marine compartment data is provided in Table 5.6-2 to give additional context. Although some potential new build sites in the UK may not have such a high local compartment volumetric exchange rate as those used in Stages 2 and 3 of the radiological assessment for the UK ABWR, the Stage 1 assessment methodology is sufficiently conservative to bound all possible scenarios. Table 5.6-1 summarises the refined datasets used in assessments, as well as their sources.

For the purposes of this UK ABWR GDA, the selected regional or local marine compartment has relatively little impact on overall public dose from all sources (liquid and gaseous discharges, and direct radiation) (see [Ref-12]). This is because the liquid discharges from the UK ABWR are infrequent and relatively low activity. Consequently, regardless of the volumetric exchange rate used, the public doses from liquid discharges are very low, whilst the overall public dose from all sources is below required dose limits and constraints [Ref-12].

It is acknowledged by Hitachi-GE that the use of the additional datasets outlined here may impact the direct applicability of a SoDA (in terms of the radiological dose assessment) to all potential nuclear new build sites in England and Wales. However, more detailed dose assessments using site-specific data will normally be made at the site-specific stage anyway to fully assess the differences in individual sites characteristics. Such site-specific information will be used in the dose assessment supporting the Environmental Permit application for the site’s radioactive substance activities.

5.4. Human and Non-Human Receptors

The Environment Agency IRAT methodology, Part 2 [Ref-11] includes details of the exposure groups that should be considered for a radiological dose assessment. For the GDA dose assessment it is assumed that there will be radioactive discharges to air and to coastal waters, and that there will not be any radioactive discharges to freshwater bodies nor to off-site sewage treatment plant. Therefore only the exposure groups relevant for releases to air and coastal sites are considered.

Table 5.4-1 shows the selected most exposed population groups used in the dose modelling for the GEP. The relevant exposure pathways are taken from habits data contained in the IRAT methodology, Part 2 [Ref-11], presented in Table 5.4-2 and Table 5.4-3, and are further discussed in the Prospective Dose Modelling report [Ref-12]. Radiological impacts on NHS are assessed using the Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) tool version 1.2; the organisms considered for the GDA are identified in Table 5.4-4. For the GEP dose assessment it is assumed that there will be no radioactive discharges to freshwater bodies so only marine and terrestrial species are considered.

Note that no data on local population distribution is required for radiological dose assessment at GDA. Collective dose assessment for the UK, EU and world population is based on the population figures shown in Table 5.4-5.

Table 5.4-1: Most Exposed Population Group by Source of Release

Source of release	Most exposed population group
Releases to air	Local resident family
Releases to coastal water	Fisherman family
Releases to river	Not considered
Releases to sewer	Not considered

Source: [Ref-11], Section 4.1.

Table 5.4-2: Habit Data of Local Resident Family Exposure Group

	Values used in IRAT Stage 1 & 2 assessments			Values used in Stage 3 assessment		
	Infant	Child	Adult	Infant	Child	Adult
Food consumption rates (kg/y)						
Green vegetables	15	35	80	5	15	35
Root vegetables	45	95	130	15	50	130
Fruit	35	50	75	9	15	20
Sheep meat	3	10	25	0.8	4	8
Sheep liver	2.75	5	10	0.5	1.5	2.75
Cow meat	10	30	45	3	15	15
Cow liver	2.75	5	10	0.5	1.5	2.75
Milk	320	240	240	320	240	95
Milk products	--	--	--	45	45	60
Breathing rates (m ³ /h)	0.22	0.64	0.92	0.22	0.64	0.92
Occupancy at habitation (h/y)	8,760	8,760	8,760	8,760	8,760	8,760
Fraction of time spent indoors	0.9	0.8	0.5	0.9	0.8	0.5
Cloud shielding factor	0.2	0.2	0.2	0.2	0.2	0.2
Shielding factor for deposited radionuclides	0.1	0.1	0.1	0.1	0.1	0.1

Source: Stage 1&2 [Ref-11], Appendix D, Table D1: Stage 3 - follows Top Two methodology, [Ref-14].

Table 5.4-3: Habit Data for Fisherman Family Exposure Group

	Values used in Stage 1-3 assessments			Fraction in compartment	
	Infant	Child	Adult	Local	Regional
Food consumption rates (kg/y)					
Fish	5	20	100	0.5	0.5
Crustaceans	0	5	20	1	0
Molluscs	0	5	20	1	0
Seaweed (only for Stage 3 assessment)	0 (mean) 0 (critical)	0 (mean) 0.5 (critical)	0.8 (mean) 2.3 (critical)	1	0
Occupancy on beach (h/y)	30	300	2,000	1	0

Source: Seaweed consumption rate¹ [Ref-16]: All other data [Ref-11], Appendix E, Table E1.

¹ There is sparse available data for these consumption rate input parameters and so conservative bounding values have been taken from across the available sources as follows. The Adult high consumption rate (2.3 kg/y) was from table 7 CEFAS Radiological Habits Survey: Heysham, 2011. The mean adult consumption rate (0.8) kg/y was derived from the mean high consumption rates of marine plants given in CEFAS Radiological Habits Surveys: Hartlepool, 2008; Heysham, 2011; Hinkey Point, 2010; Sizewell, 2010; Wylfa, 201. The child high consumption rate (0.5 kg/y) was taken from table B CEFAS Radiological Habits Survey: Sizewell, 2010.

Table 5.4-4: Reference Organisms Considered in the Vicinity of the Generic Site

Terrestrial	Marine
Amphibian	Bird
Annelid	Reptile
Arthropod - detritivorous	Benthic fish
Bird	Crustacean
Flying insects	Macroalgae
Grasses & Herbs	Mammal
Lichen & Bryophytes	Mollusc - bivalve
Mammal - large	Pelagic fish
Mammal - small-burrowing	Phytoplankton
Mollusc - gastropod	Polychaete worm
Reptile	Sea anemones & True coral
Shrub	Vascular plant
Tree	Zooplankton

Source: [Ref-13]

Table 5.4-5: UK, EU and World Population Figures

Country/Region	Population
UK	5.96×10^7
EU25	4.56×10^8
World	1.00×10^{10}

Source: [Ref-15], Table 5.12

5.5. Meteorological Data

Local meteorological data is not required for any of the assessments carried out at GDA. The radiological dose assessment at GDA follows the IRAT methodology, and so uses a uniform wind rose together with the atmospheric conditions given in Table 5.5-1.

Table 5.5-1: Atmospheric Conditions

Pasquill Stability Category	Frequency of Occurrence (%) – IRAT Stage 1 & 2	Frequency of Occurrence (%) - Stage 3	Wind Speed at 10m Height (m/s)
A	1	0.3	1
B	9	4	2
C	21 (10% rain)	14 (10% rain)	5
D	50 (10% rain)	70 (10% rain)	5
E	8	6	3
F	10	5	2
G	2	0.7	1

Sources: IRAT Stages 1 & 2 [Ref-11], Appendix D, Table D2; Stage 3 radiological assessment [Ref-9], Figure 11

5.6. Geographical Information

The information shown in Table 5.6-1 has been used in the radiological dose assessments presented in the Prospective Dose Modelling report [Ref-12] and a comparison of each potential site's marine compartment data is provided in Table 5.6-2.

Table 5.6-1: Geographical Information Used in the Radiological Dose Assessments

Item	Unit	IRAT Stage 1 & 2 Value	Stage 3 Value
Public receptor point aerial discharges	m	100 from discharge point*	270
Food production receptor point	m	500 from discharge point*	500
Site boundary	m	100	270
Surface roughness	m	0.3	0.3
Washout coefficient	Per s	1×10^{-4} , 0 for noble gases*	1×10^{-4} , 0 for noble gases*
Marine Module	-	Not applicable	Reference site (Wylfa)
Regional compartment	-	Not applicable	Irish sea west†
Local compartment volumetric exchange rate	m ³ /y	$3.2 \times 10^{9*s}$	$4 \times 10^{10}†$
Local compartment volume	m ³	10^8*	$2 \times 10^9†$
Local compartment depth	m	$10*$	$20†$
Local compartment coastline length	m	10^4*	$10^4†$
Local compartment suspended sediment load	t/m ³	$10^{-5}*$	$10^{-5}†$
Local compartment sediment rate	t/m ² /y	$4.9 \times 10^{-3}*$	$5.0 \times 10^{-3}†$
Local compartment sediment density	t/m ³	$2.6*$	$2.6†$
Local compartment bioturbation rate	m ² /y	$3.6 \times 10^{-5}*$	-
Local compartment diffusion rate	m ² /y	$3.15 \times 10^{-2}*$	$3.15 \times 10^{-2}†$

Sources: * [Ref-11] † [Ref-15] ^s This value was used for the IRAT Stage 1 assessment. A value of 1300m³/s was used for the IRAT Stage 2 assessment. 1300m³/s translates to value of 4×10^{10} m³/y i.e. it is equivalent to that value used for the Stage 3 assessment.

Table 5.6-2: Local Compartment Volumetric Exchange Rates and Associated Regional Compartments

Local compartment	Volumetric exchange rate (m ³ /y)	Regional compartment
Bradwell	4.0×10^9	North Sea SouthWest
Dungeness	8.0×10^{10}	Isle of Wight
Hartlepool	4.0×10^9	North Sea Central
Heysham	8.0×10^9	Liverpool and Morecambe Bays
Hinkley point	1.0×10^{11}	Bristol Channel
Oldbury	4.0×10^9	Bristol Channel
Sellafield	5.0×10^{11}	Cumbrian Waters
Sizewell	1.1×10^{10}	North Sea South West
Wylfa	4.0×10^{10}	Irish Sea West

Source: [Ref-15]

5.7. Designated Sites

Only the generic site characteristics needed for the radiological dose assessment have been included in this site description. Information on designated sites will be utilised in the site-specific Environmental Permitting process. No designated sites have been assumed in the generic site used for the radiological assessment in the GEP.

5.8. Marine Data

Relevant marine data is already included in the assessments undertaken in the Prospective Dose Modelling report of the GEP submission [Ref-12], summarised in part here in Table 5.6-1. Site-specific data will be used in the radiological dose assessment supporting the site-specific Environmental Permitting process.