

**Generic design assessment  
AP1000 nuclear power plant design by  
Westinghouse Electric Company LLC**

**Assessment report  
Generic site**



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Environment Agency  
Rio House  
Waterside Drive, Aztec West  
Almondsbury, Bristol BS32 4UD  
Tel: 0870 8506506

Email: [enquiries@environment-agency.gov.uk](mailto:enquiries@environment-agency.gov.uk)

[www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)

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## Generic design assessment

### AP1000 nuclear power plant design by Westinghouse Electric Company LLC

#### Assessment report – generic site characteristics

<b>Protective status</b>	This document contains no sensitive nuclear information or commercially confidential information.
<b>Process and Information Document<sup>1</sup></b>	<p>The following sections of Table 1 in our Process and Information document are relevant to this assessment:</p> <p>Section 1.3 The Generic Site Characteristics that the requesting party wishes us to take into account when assessing the environmental impact of the reactor design. If we issue any statement of acceptability after our assessment it would be on the basis of these characteristics. A range of generic sites might be addressed with coastal, estuarine and inland characteristics.</p>
<b>Radioactive Substances Regulation Environmental Principles<sup>2</sup></b>	<p>The following principles are relevant to this assessment:</p> <p>SEDP1 General RSR Principle for siting new facilities - When evaluating sites for a new facility, account shall be taken of the factors that might affect the protection of people and the environment from radiological hazards and the generation of radioactive waste.</p>
<b>Report author</b>	Julie Tooley

1. Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs, Environment Agency, Jan 2007.

<http://publications.environment-agency.gov.uk/pdf/GEHO0107BLTN-e-e.pdf>

2. Regulatory Guidance Series, No RSR 1: Radioactive Substances Regulation - Environmental Principles (REPs), 2010.

<http://publications.environment-agency.gov.uk/pdf/GEHO0709BQSB-e-e.pdf>

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## 1 Summary

1 In order to demonstrate that discharges and other environmental impacts from the reactor designs would be consistent with UK dose constraints and limits and other UK environmental constraints and limits and hence be amenable to authorisation, we require a typical UK (generic) site to be defined against which the impacts from the reactor designs can be assessed.

2 We have carried out an assessment of Westinghouse's generic site characteristics.

3 We consider that the AP1000 generic site characteristics are justified and reasonable for the generic design assessment (GDA) stage and represent a conservative yet realistic approach. We consider the parameters and their values which define the AP1000 generic site are appropriate for use in the assessment of radiological impact at the GDA stage. We recognise that detailed site-specific assessments of the radiological impact from the AP1000 will be required at the site-specific stage using data and information which relates to the site at which an AP1000 reactor may be located. This is dealt with in our Assessment Reports on the radiological impacts on members of the public and non-human species (Environment Agency, 2010b and 2010c).

4 We conclude that Westinghouse's generic site parameters and their values which define its generic site are appropriate for use in its assessment of radiological impact at the GDA stage.

5 Our findings on the wider environmental impacts and waste management arrangements for the AP1000 reactor may be found in our Consultation Document (Environment Agency, 2010a).

## 2 Introduction

6 In order to assess the potential impact of a particular reactor design on the environment we need to know the characteristics of the generic site proposed by Westinghouse. We recognise that at the generic design assessment stage the specific location of the nuclear plant is not known and therefore the impact assessment will be a scoping assessment which will be followed by a significantly more detailed site-specific assessment once the locations of the plants and associated receptors are better known. However, at the generic design assessment stage we need to satisfy ourselves that:

- a) the reactor design is such that any environmental impacts would be acceptable to the UK;
- b) any particular features of the reactor design which may lead to impacts of a type or magnitude which could constrain the locations at which such a plant could be located are identified;
- c) any environmental impacts of the new build reactors in the UK are as low as reasonably achievable (ALARA), in line with the policy set out in the Energy White Paper (BERR, 2008).

7 In order to demonstrate that discharges and other environmental impacts from the reactor designs would be consistent with UK dose constraints and limits and other UK environmental constraints and limits, and hence be amenable to authorisation, we require a typical UK (generic) site to be defined against which the impacts can be assessed.

8 The types of parameters that may be included in the site descriptions are:

- a) Physical aspects of the location.
- b) Distance to nearest occupied buildings, centres of population.

- c) Habits of local population.
  - d) Impacts on non-human biota.
  - e) Local presence of designated or protected sites e.g. Sites of Special Scientific Interest (SSSIs<sup>1</sup>), Special Protection Areas (SPAs<sup>2</sup>) or Ramsar sites<sup>3</sup>.
  - f) Physical parameters such as meteorological dispersion parameters, liquid discharge parameter, atmospheric discharge parameters and abstraction parameters.
- 9 Westinghouse has derived its AP1000 generic site characteristics assuming the AP1000 will be located at a coastal site. The generic site characteristics are based on information obtained from five coastal nuclear power stations around the UK. These power stations are Dungeness, Hartlepool, Heysham, Hinkley Point and Sizewell.
- 10 During the assessment certain matters were identified and dealt with using the Regulatory Observation and Technical Query system.

### 3 Assessment

- 11 This assessment considers the generic site described by Westinghouse which has been used in the assessment of the potential impact of an AP1000 on members of the public and non-human species. We have taken into account Statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment (DECC, 2009) which sets out the principle that:
- a) regulatory justification of practices should be carried out by the Government;
  - b) optimisation of protection on the basis that radiological doses and risks to workers and members of the public from a source of exposure should be kept as low as reasonably achievable (the ALARA principle);
  - c) application of limits and conditions to control discharges from justified activities;
  - d) sustainable development;
  - e) the use of Best Available Techniques (BAT);
  - f) the precautionary principle;
  - g) the polluter pays principle;
  - h) the preferred use of 'concentrate and contain' in the management of radioactive waste over 'dilute and disperse' in cases where there would be a definite benefit in reducing environmental pollution, provided that BAT is being applied and worker dose is taken into account.

#### 3.1. Assessment methodology

- 12 The basis of our assessment was to:
- a) consider the submission made by Westinghouse in particular the Environment Report and its supporting documents;

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<sup>1</sup> Site of Special Scientific Interest Identified / notified by English Nature or the Countryside Council for Wales under the Wildlife and Countryside Act 1981 for its importance to nature conservation

<sup>2</sup> Special Protection Areas. An area classified as such under the EC Birds Directive to provide protection to birds, their nests, eggs and habitats: areas that are internationally important sites designated under the EEC Wild Birds Directive.

<sup>3</sup> A site of international conservation importance classified at the 'Convention on Wetlands of International Importance' 1971, ratified by the UK Government in 1976.

- b) hold technical meetings with Westinghouse to clarify our understanding of the information presented and explain any concerns we had with that information;
  - c) raise Regulatory Observations and Technical Queries where we believed information provided by Westinghouse was insufficient;
  - d) assess the generic site characteristics proposed by Westinghouse and decide if they are reasonable;
  - e) decide on any potential GDA Issues or other issues to carry forward from GDA, should we decide to issue a Statement of Design Acceptability.
- 13 Westinghouse provided its GDA submission for the AP1000 in August 2007. We carried out our initial assessment and concluded we needed additional information. We raised a Regulatory Issue on Westinghouse in February 2008 setting out the further information that we needed. Westinghouse completely revised its submission during 2008 and provided an Environment Report with supporting documents.
- 14 We assessed information contained in the Environment Report but found that while much improved from the original submission there were some areas where we required further information.
- 15 We raised 42 Technical Queries (TQs) on Westinghouse during our assessment. Seven were relevant to this report (in part):
- a) TQ-AP1000-144 – Generic site - number of population centres. 1 June 2009.
  - b) TQ-AP1000-150 – Dose assessment assumptions – effective release height. 1 June 2009.
  - c) TQ-AP1000-151 - Dose assessment assumptions – short-term releases. 1 June 2009.
  - d) TQ-AP1000-152 – Generic site – location of nearest properties. 1 June 2009.
  - e) TQ-AP1000-178 – Non-human species impact assessment - general issues. 2 July 2009.
  - f) TQ-AP1000-179 – Non-human species impact assessment - coastal assessment. 2 July 2009.
  - g) TQ-AP1000-180 – Non-human species impact assessment - terrestrial assessment. 2 July 2009.
- 16 Westinghouse responded to the TQ's. It reviewed and updated the Environment Report in April 2010 to include all the relevant information provided by the TQs. This report refers to the information contained in the updated Environment Report (UKP-GW-GL-790 (Rev 3)) and its supporting documents.

### 3.2. Assessment objectives

- 17 Key areas of the submission made under the GDA arrangements by Westinghouse for the AP1000 design that have been considered are:
- a) Are the generic site characteristics reasonable and justified?
  - b) Are there any aspects of the generic site that would preclude any location at site-specific permitting?

### 3.3. Westinghouse documentation

18 We referred to the following documents to produce this report

Document reference	Title	Version number
UKP-GW-GL-790	UK AP1000 Environment Report	2,3
UKP-GW-GL-025	Generic Site Report	1

19 We use short references in this report, for example:

a) ER sub-chapter 6.2 section 1.2.1 = ERsc6.2s1.2.1.

### 3.4. Assessment findings

20 We have assessed the information on the generic site in the submission made by Westinghouse for its AP1000 design. The information is primarily in Chapter 5 of the Environment Report UKP-GW-GL-790 (Rev 3).

21 During the assessment certain matters were identified and dealt with using the Regulatory Observation and Technical Query system.

22 Technical Query TQ-AP1000-144 was raised on 1 June 2009 which required Westinghouse to clarify its approach to determining the number of population centres within a given distance from the generic site. Westinghouse responded on 25 June 2009 setting out that the generic site characteristics were based on typical characteristics of five existing nuclear power station sites – Dungeness, Hartlepool, Heysham, Hinkley Point, and Sizewell.

23 Westinghouse identified the number of population centres of a specific size within 2 km, 10 km and 20 km of these existing sites. The population sizes selected were <1000, >1000, >5000, >20,000, >100,000. Westinghouse then identified the distance between the nearest population centre of a given size and the power station. Initially it was proposed that the generic site should be allocated with the largest number of population centres observed at any of the five existing sites and that at least one of the population centres of each size should be located at closest distance observed at any of the existing sites. However, the selection of both these criteria proved incompatible and resulted in a generic site map which Westinghouse considered to be completely unrealistic with too many population centres too close to the site. Westinghouse considered that the only way to make the generic site map more realistic was to reduce the number of population centres. As the generic site is based on characteristics of five existing sites, selection of the 80th percentile should ensure that four of the five sites are encompassed by the 80th percentile value. Westinghouse claimed that by selecting the 80th percentile number of population centres that a generic site map that was both conservative and realistic could be achieved. Westinghouse considered that the distance between the nuclear power station and the population centre is the most important parameter in ensuring the generic site is characterised conservatively. Westinghouse decided that at least one of the selected population centres of each size should be located at closest distance observed at any of the existing sites.

24 Technical Query TQ-AP1000-150 was raised on 1 June 2009 which required Westinghouse to justify the extent to which building downwash had been considered in the calculation of the value for effective release height for the main stack used in its dose assessments. Westinghouse responded on 20 August 2009 and its response included a reassessment of doses using an effective release height of 22.5 m which had been calculated taking into account building downwash. The information was



- included in the Environment Report UKP-GW-GL-790 (Rev 2 and 3) Section 5.2.1.2. The information was also taken into account by the contractor undertaking the validation and verification of Westinghouse's dose assessment. A revised dose assessment was included in Environment Report UKP-GW-GL-790 Rev 2 and 3, Chapter 5.
- 25 Technical Query TQ-AP1000-151 was raised on 1 June 2009 and required Westinghouse to provide information on certain assumed data it had used in its short-term dose assessment. Westinghouse responded on 22 June 2009 and its response was taken into account by the contractor undertaking the validation and verification of Westinghouse's dose assessment. The information was included in the Environment Report UKP-GW-GL-790 (Rev 2 and 3) Section 5.2.1.4.
- 26 Technical Query TQ-AP1000-152 was raised on 1 June 2009 and required Westinghouse to provide information on data it had used in its generic site description relating to the location of the nearest properties. Westinghouse responded on 30 June 2009 and its response was taken into account by the contractor undertaking the validation and verification of Westinghouse's dose assessment. The information was included in the Environment Report UKP-GW-GL-790 (Rev 2 and 3) Section 5.2.1.2.
- 27 Technical Query TQ-AP1000-169 was raised on 19 June 2009 and required Westinghouse to provide information on Atmospheric Dispersion Modelling System (ADMS) input data it had used in its short-term dose assessment. Westinghouse responded on 13 August 2009 and its response was taken into account by the contractor undertaking the validation and verification of Westinghouse's dose assessment. The information was included in the Environment Report UKP-GW-GL-790 (Rev 2 and 3) Section 5.2.1.4.
- 28 Technical Query TQ-AP1000-178 was raised on 2 July 2009 which required Westinghouse to provide further general information in order that we could carry out an independent assessment of the impact on non-human species. We required Westinghouse to clarify certain data used in its non-human species assessment and to set out its approach to assessment of the impact on the freshwater eco-system. Westinghouse responded on 20 August 2009 by providing the information requested and it repeated the assessment and revised the Environment Report s 5.3.1. to reflect the new assessment. Westinghouse confirmed that it did not foresee any discharges to the freshwater eco-system. The information was included in the Environment Report UKP-GW-GL-790 (Rev 2 and 3) Section 5.3.1.
- 29 Technical Query TQ-AP1000-179 was raised on 2 July 2009 and required Westinghouse to provide further information relating to its coastal assessment of the impact on non-human species. Westinghouse responded on 20 August 2009 by providing the information requested and it repeated the assessment and revised the Environment Report UKP-GW-GL-790 (Rev 2 and 3) section 5.3.1 to reflect the new assessment.
- 30 Technical Query TQ-AP1000-180 was raised on 2 July 2009 required Westinghouse to provide further information relating to its terrestrial assessment of the impact on non-human species. Westinghouse responded on 24 August 2009 by providing the information requested and it repeated the assessment and revised the Environment Report UKP-GW-GL-790 (Rev 2 and 3) section 5.3.1 to reflect the new assessment.
- 31 Westinghouse assumed a coastal generic site with no freshwater eco-systems. The generic site characteristics are based on information obtained from five coastal nuclear power stations around the UK. These power stations are Dungeness, Hartlepool, Heysham, Hinkley Point and Sizewell.
- 32 Westinghouse's AP1000 generic site characteristics include data on:
- a) **Human population** – Westinghouse has analysed the centres of population within 20 km of the five power station sites and has assumed that the generic site has the 80th percentile number of population centres within a given distance. It has

derived the number of population centres with a population of >100,000, >20,000, >5000, >1000, ≤1000 and farms and properties at distances of <1 km, <2 km, <10 km and <20 km from the generic site. For each size of population it has identified the closest distance that a population of such a size is to the generic site.

Westinghouse chose to use the 80th percentile number of population centres within a given distance as it considers that this gives a conservative yet realistic generic site. ER Table 5.1-1

- b) **Exposed population groups** – for dose assessment purposes Westinghouse has considered two exposure groups:
- i) The local resident family selected to represent exposure pathways associated with atmospheric releases from the AP1000. The local resident family comprises infants, children and adults who live 100 m from the aerial discharge point. They spend most of their time at home, some of which is spent outdoors. They eat green vegetables, root vegetables from their garden or other local sources within 100 m of the aerial discharge point and milk and meat from local farms within 500 m of the aerial discharge point. They eat small amounts of locally caught fish and shellfish.
  - ii) The fisherman family selected to represent the exposure pathways associated with discharges from the AP1000 to the coastal environment. The fisherman and his family are assumed to spend time on intertidal sediments in the area and consume high levels of locally caught fish and shellfish in addition to small amounts of locally produced fruit and vegetables from local sources up to 500 m from the aerial discharge point. This group live far enough from the site not to be exposed to direct radiation from atmospheric releases.

Habits data which includes such matters as food consumption rates, breathing rates and occupancy rates for three age groups (1 year old infant, 10 year old child and adult) have been used which are consistent with habits data published in recognised sources such as NRPB-W41 (NRPB, 2003). (ER Tables 5.1.2 and 5.1.3)

- c) **Non-human species** – The use of reference organisms in the assessment of impact on non-human species is an accepted practice. The reference organisms have defined anatomical and physiological properties and habits and represent typical organisms in the ecosystem. Westinghouse has selected a range of terrestrial and marine reference organisms which it considers to represent all European protected species and it has assumed the terrestrial reference organisms to be located at the site boundary and the marine reference organisms to be 150 m from the discharge point. (ER Table 5.1.4)
- d) **Meteorology** – Meteorological data has been derived for the generic site from worst case maximum, worst case minimum and average data for the five power station sites. Data on atmospheric conditions and atmospheric deposition coefficients have been used which are consistent with data published in recognised sources such as the Environment Agency Initial Radiological Assessment Methodology (Environment Agency, 2006) and IAEA SR19 (IAEA, 2001). (ER Table 5.1.5 and 5.1.6)
- e) **Terrestrial environment** – it has been assumed that the highest elevation within 2 km of the generic site is 30 m high and within 10 km is 358 m high. Land cover around the generic site is generally assumed to be arable, grassland, dunes and some woodland. A surface roughness of 0.3 m has been assumed which is typical of a rural location. It is assumed the land is stable with few geological faults and the geology is glacial clay with sand and gravel lenses. Perched groundwater is assumed to be 2 m below the surface and the generic site overlies a major aquifer with a groundwater level 20 m below the surface. Based on British Geological Survey data it has been assumed that the generic site has the potential to experience an earthquake of 6.5 magnitude on the Richter scale. A number of

sensitive or designated sites are assumed to present in the vicinity of the generic site, the nearest being a Site of Special Scientific Interest which is 180 m from the generic site. (ER tables 5.1.7, 5.1.8, 5.1.9 and 5.1.10)

- f) **Coastal environment** – tidal ranges have been assumed to be between -0.06 m and 11.17 m. The volumetric flow rate has been assumed to be 130 m<sup>3</sup> s<sup>-1</sup> which is the most conservative exchange rate associated with the five power station sites. Sand, gravel, rock, mud and made ground (or combinations of these substrates) which are found at the five power station sites are assumed to be present in the intertidal zone. The bathymetry assumed for the generic site assumes water depth in terms of Admiralty Chart Datum to range from -15 m to 5 m over a distance of 10 km from the generic site. A range of marine biological features such as water and wildfowl areas, sensitive fish areas and seabird nesting colonies are assumed to be present within 10 km of the generic site. (ER tables 5.1.11, 5.1.12 and 5.1.13)
- 33 Westinghouse has used the AP1000 generic site characteristics in its assessment of the potential radiological impact of the AP1000 on members of the public and non-human species.
- 34 In our independent dose assessment carried out on our behalf by Enviro Consulting Ltd (Environment Agency, 2010d) Table A.2 of Appendix 2 of the report sets out comments on Westinghouse’s approach to dose assessment which includes comments on the values of generic site parameters used by Westinghouse.
- 35 We consider that the AP1000 generic site characteristics are justified and reasonable for the GDA stage and represent a conservative approach whilst retaining a sufficient amount of realism. We consider the parameters and its values which define the AP1000 generic site are appropriate for use in the assessment of radiological impact at the GDA stage. We recognise that detailed site-specific assessments of the radiological impact from the AP1000 will be required at the site-specific stage using data and information which relates to the site at which an AP1000 reactor may be located.

**3.5. Compliance with our requirements**

P&I table 1 section or REP	Compliance comments
<b>Section 1.3:</b> We require the Generic Site Characteristics that the requesting party wishes us to take into account when assessing the environmental impact of the reactor design. A range of generic sites might be addressed with coastal, estuarine and inland characteristics.	Westinghouse provided characteristics and data for its generic site. Westinghouse described a single generic site which was a coastal site.
<b>SEDP1</b> General RSR Principle for siting new facilities - When evaluating sites for a new facility, account shall be taken of the factors that might affect the protection of people and the environment from radiological hazards and the generation of radioactive waste.	The generic site proposed by Westinghouse considered factors that might affect the protection of people and the environment. The information about the generic site used in the dose assessments seemed reasonable.

## 4 Public Comments

36 We did not receive any public comments during this assessment relating to the generic site characteristics.

## 5 Conclusion

37 We consider that the AP1000 generic site characteristics are justified and reasonable for the GDA stage and represent a conservative approach whilst retaining a sufficient amount of realism. We consider the parameters and its values which define the AP1000 generic site are appropriate for use in the assessment of radiological impact at the GDA stage. We recognise that detailed site-specific assessments of the radiological impact from the AP1000 will be required at the site-specific stage using data and information which relates to the site at which an AP1000 reactor may be located. This is dealt with in our Assessment Reports on the radiological impacts on members of the public and non-human species (Environment Agency, 2010b and 2010c).

38 We conclude that Westinghouse's generic site parameters and its values which define its generic site are appropriate for use in its assessment of radiological impact at the GDA stage.

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## Abbreviations

ADMS	Atmospheric Dispersion Modelling System
ALARA	As low as reasonably achievable
AP1000™	AP1000 is trademark of Westinghouse Electric Company LLC.
BAT	Best available techniques
DCD	Design Control Document
ER	UK AP1000 Environment Report
ERs*.*	Environment Report section reference e.g. 3.2.2.2
GDA	Generic Design Assessment
IAEA	International Atomic Energy Agency
JPO	Joint Programme Office
NRPB	National Radiological Protection Board (now part of Health Protection Agency)
PCSR	Pre-Construction Safety Report
RI	Regulatory Issue
RO	Regulatory Observation
SPA	Special Protection Areas.
SSSI	Site of Special Scientific Interest Identified / notified by English Nature or the Countryside Council for Wales under the Wildlife and Countryside Act 1981 for its importance to nature conservation
TQ	Technical Query
WEC	Westinghouse Electric Company LLC

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