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UK ABWR Generic Design Assessment

Generic PCSR Chapter 2 : Generic Site Envelope

Hitachi-GE Nuclear Energy, Ltd.

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Table of Contents

2.1 Introduction

This document describes the methodology for defining the generic site data envelope, relating to appropriate external hazards, into a series of Generic Site Conditions. These Generic Site Conditions can then be used for the generic design of the Standard UK ABWR Structures, Systems and Components (SSCs) for any specific candidate site in the UK.

The Generic Site Conditions will take into account the naturally occurring environmental external hazards and man-made external hazards. The process of identification of the all External Hazards and grouping are described in Chapter 6 “External Hazard”. More than 100 hazards are identified and grouped into 14 groups listed below:

- Air Temperature
- Wind
- Rainfall & Ice
- Drought
- Snow
- Electromagnetic Interference (EMI)
- Sea or River Water Temperature
- External Flooding
- Seismic Activity (Earthquake)
- Loss of Offsite Power
- Aircraft Impact (AIA)
- External Fire
- External Missile
- External Explosion

The structure of the document for this Chapter and Chapter 6 “External Hazard” is shown in Fig. 2.1-1.

The preliminary values and TBD (To Be Determined) described in this document will be evaluated and defined in GDA Step 3.

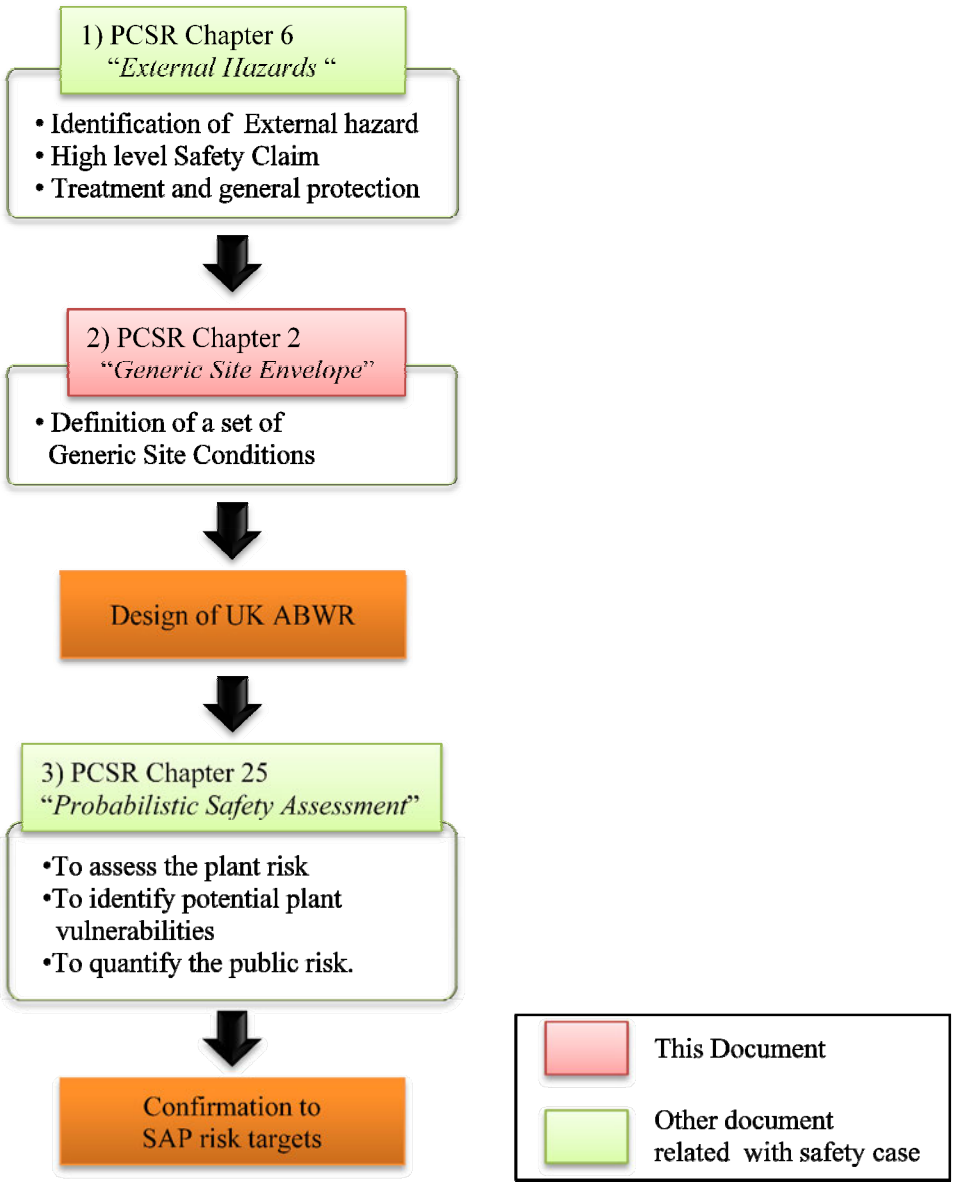

Fig.2.1-1 : Safety Case Document Structure for External Hazard Assessment

2.2 Scope of Generic Site Envelope

This document defines representative parameters which will be used for actual UK ABWR design for each 14 External Hazards groups identified in Chapter 6 “External Hazard”.

The representative parameters for the 14 External Hazards groups will be bounded into a set of Generic Site Conditions that can be used for potential UK ABWR sites in the UK. Standard UK ABWR Structures, Systems and Components (SSCs) will be designed to accommodate the Generic Site Conditions.

As background to the UK ABWR project, the most preferable UK candidate site is already defined. As an approach to define Generic Site Conditions of the UK ABWR, the site conditions of the candidate site are considered as the bases of Generic Site Conditions to minimise the risks will appear in Site License and to create suitable UK ABWR design in GDA process. Representative values of each 14 External Hazards groups are defined based on the candidate site condition considering generality explained in next paragraph and margin.

Generic Site Conditions for the UK ABWR will be defined based on the consideration of current good practice in the UK using appropriate codes and standards. This will include consideration of extreme values taken from historical data, and where appropriate will allow for the influence of climate change for the candidate nuclear specific sites.

Representative values of each 14 External Hazards groups will be evaluated and finalized in Step3.
The consequence analysis of conditions will be carried out based on National Policy Statement of Nuclear Power Generation EN-6 [Ref-1] in Step 3.

2.3 Generic Site Envelope

Actual methodology and considerations for the evaluation of the representative values are described in this section. All representative values will be finalised in Step 3.

The 14 External Hazards groups identified in Chapter 6 “External Hazard” are discussed in this document under the following sections:

- Heat Sink - Possible type of heat sink source(heat sink for accident condition / normal condition) / Temperature (including Climate change); (refer to section 2.3.1)
- Meteorology - Air temperature Wind load / Tornado / Precipitation / Humidity; (refer to section 2.3.2)
- Hydrology - Sea water level (including Climate change) / External flooding / elevation; (refer to section 2.3.3)
- Soil and Seismic Input - Seismic /Soil Properties; (refer to section 2.3.4)
- Electrical and Grid Connections - EMI / Condition of the Grid Connections / Loss Of Offsite Power (LOOP). (refer to section 2.3.5)
- Other External Hazards (refer to section 2.3.6)

These assessments shall include the possible influence of climate change, based on the information currently available. However many parameters need further investigation to incorporate climate change. Table 2.4-1 provides a summary of the design parameters.

Relationship between the 14 External Hazards groups identified in Chapter 6 “External Hazard” and sections in Generic Site Envelope are shown in Figure 2.3-1.

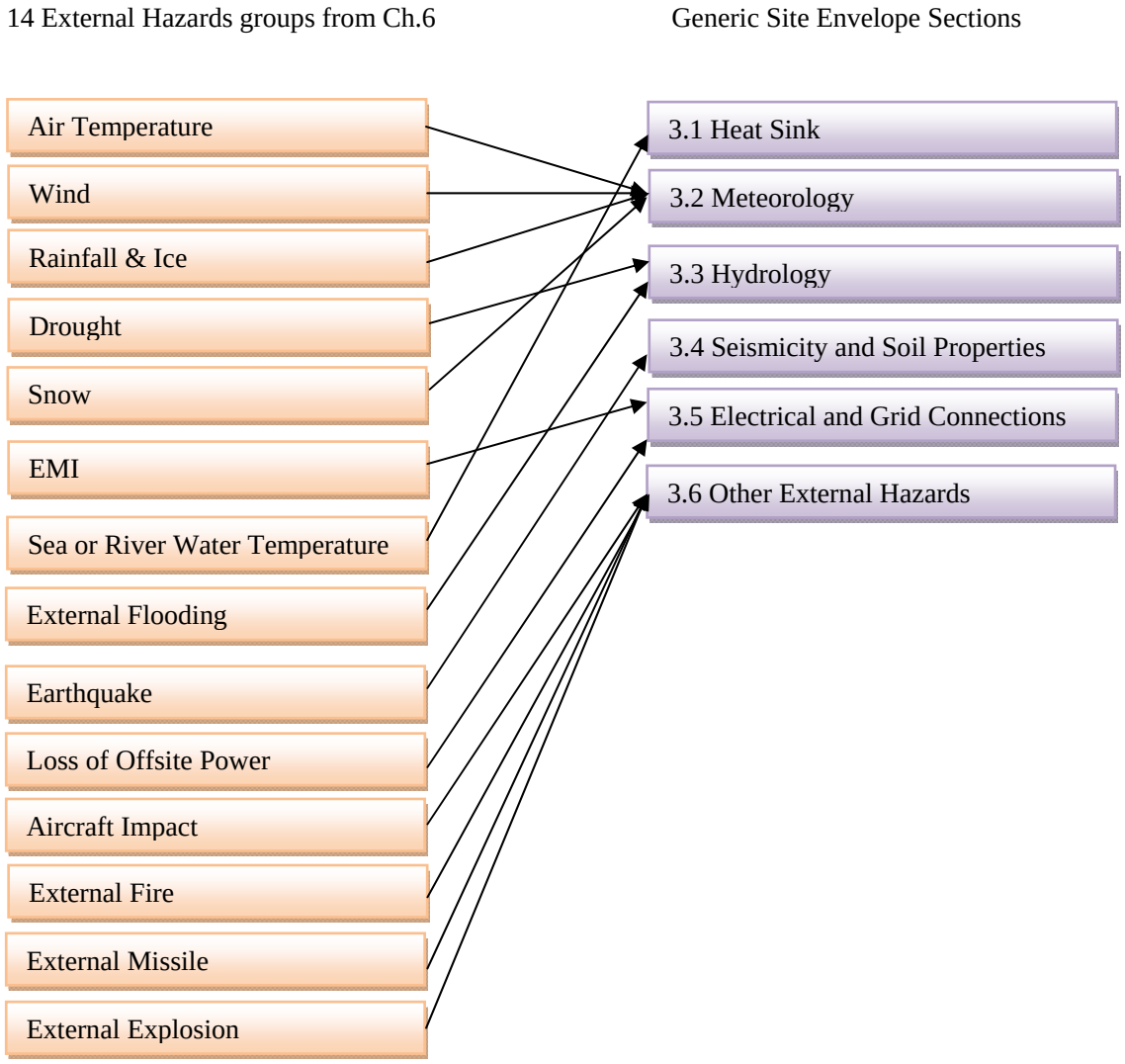

Fig. 2.3-1 : Contents of Generic Site Envelope Sections

Each sections of this report generally discusses the input information under the following:

(a) Candidate Site Condition

(b) General Information

(c) Envelope Condition

2.3.1 Heat Sink

The UHS (Ultimate Heat Sink) serves the safety-related functions of providing cooling water and acting as a heat sink for the system during accident conditions. The UHS also serves as a heat sink during normal operation by accepting the heat load from the Reactor Building Cooling Water Heat Exchanger (RCW-HEX) which serves the reactor building support systems.

The Reactor Building Service Water System (RSW) supplies cooling water to the RCW-HEX and releases the heat inputted from the Reactor Building Cooling Water System (RCW) to the UHS during plant normal, start-up/shutdown and transient operation.

The UHS is designed to provide an adequate source of cooling water which is available at all times for reactor operation, shutdown cooling and for accident mitigation. The cooling water systems such as RCW and RSW and the heat removal systems including the Residual Heat Removal System (RHR) are also designed based on water temperature of this UHS. The minimum and maximum cooling water temperatures of UHS for UK ABWR are determined with taking into account the following conditions.

(a) Candidate Site Condition

The sea water temperature in the candidate site condition is evaluated based on the following assumptions.

- The sea water temperatures in the adjacent areas including candidate site, which have been gathered by Cefas (The Centre for Environment, Fisheries and Aquaculture Science), the environment administrative agency, are utilized.
- For these data, the seawater temperatures are evaluated in consideration of Return Period (1/20, 1/100, 1/200, 1/1,000 and 1/10,000).
- The temperature increase caused by climate change is added to the above temperature value.

(b) General Information

"Volume 2 Generic Nuclear Island requirements, Chapter 4 Design Basis" [Ref-2] issued by EUR (European Utility Requirements for LWR Nuclear Power Plant) specifies that the design shall be adaptable to the following range of cooling water temperatures at the intake.

	Sea water		River	
	Min.	Max.	Min.	Max.
Temp.	-0.5°C	30°C	0°C	30°C

(c) Data in Other Area

The maximum or minimum sea water temperature is evaluated in taking into account to the historical data of seawater surface temperature for a range of sites around the UK shores.

With taking into account to the candidate site condition, general information, etc., the minimum and maximum cooling water temperatures of UHS for UK ABWR are set to the following table.

	Set Value
Maximum cooling water temperature for RSW	30°C [Preliminary]
Minimum cooling water temperature for RSW	-1.6°C (Sea water) [Preliminary] 0°C (River or Cooling tower) [Preliminary]

For maximum temperature, EUR condition covers candidate site condition (including climate change) and Data in Other Area. Therefore, 30°C from EUR was chosen as the maximum cooling water temperature.

For minimum temperature, we recognize further work is required and have shown a minimum temperature of -1.6^{o}C as adopted for the Bristol Channel. This will need to be confirmed for the Candidate Site.

The heat sink serves the heat removal from the Turbine Building Cooling Water Heat Exchanger (TCW-HEX) which serves the turbine building support systems and the steam turbine main condenser which release heat from the turbine exhaust steam. The Turbine Building Service Water System (TSW) and the Circulating Water System (CW) supply cooling water to the TCW-HEX and the steam turbine main condenser respectively, and release their heat to the heat sink during plant normal, start-up/shutdown and transient operation.

(a) Envelope Condition for TSW and CW

The TSW, CW, TCW-HEX and steam turbine main condenser are designed based on the seawater temperature.

The minimum and maximum cooling seawater temperatures for UK ABWR are determined in consideration of candidate site conditions as the following.

- Historical data of seawater surface temperature for a range of candidate site shore recorded by Cefas (The Centre for Environment, Fisheries and Aquaculture Science).
- Climate change

  The seawater temperature 60 years later with climate change is estimated since TCW-HEX and the steam turbine main condenser have no heat duty after the decommissioning start.

(b) Conclusion for TSW and CW

The TSW and CW of UK ABWR are designed based on the following condition as the cooling seawater temperatures from heat sink.

For maximum temperature; 18.9°C of future is the highest temperature at candidate site. Therefore 21°C is set for the maximum temperature in consideration of margin.

For minimum temperature; 5.1°C of historical data is the lowest temperature at candidate site. Therefore 3°C is set for the minimum temperature in consideration of margin.

- Maximum heat sink Temperature for TSW and CW : 21°C [Preliminary]
- Minimum heat sink Temperature for TSW and CW : 3°C [Preliminary]

2.3.2 Meteorology

2.3.2.1 Basic Policies

(a) Meteorological Conditions

Meteorological Conditions for UK ABWR generic site are determined in consideration of enveloping both of the following conditions with appropriate climate change scenario and margin.

(i) Candidate site conditions

These are conservatively assumed based on the historical data of candidate site conditions.

(ii) Generic design conditions for Generic Candidate Sites in England and Wales.

These are assumed based on the industrial codes and standards or practice in the UK, i.e. Eurocode and UK National Annex.

(b) Return Period

(i) Return Period of the Normal Condition

The “100 years” is assumed as the return period of the normal condition, which are considered operation and decommission.

(ii) Return Period of the Extreme Condition

The “10,000 years” is assumed as the return period of the extreme condition.

2.3.2.2 Air Temperature

Air Temperature for UK ABWR generic site is determined considering following three definitions.

(1) Design temperature for normal HVAC

(2) Design temperature for civil and structural components for normal condition

(3) Design temperature for both emergency HVAC and civil and structural components for extreme condition

Design temperature for normal HVAC is air temperature for non safety classified HVAC. And this will be designed with the temperature of normal industrial practice.
In this section, considerations of other two air temperature conditions are mainly described.

(a) Candidate Site Condition

(i) Design temperature for civil and structural components for normal condition

The value of 10^{-2} p.a. return frequency will be used for the normal condition temperature of buildings considering the plant operating period of 60 years and decommissioning period.

(ii) Design temperature for both emergency HVAC and civil and structural components for extreme condition

The value of 10^{-4} p.a. return frequency will be taken into consideration to determine the value for safety classified HVAC and buildings. The detailed method will be discussed and the temperature extremes should be determined in Step 3.

The maximum and minimum air temperatures for the candidate site of (1) and (2) will be evaluated based on the historical record of extreme air temperatures at or around the candidate site.

(b) General Information

The maximum and minimum air temperatures for the Generic Candidate Sites for 50 years return period are evaluated from Figure NA.1 and NA.2 of NA to BSEN 1991-1-5:2003 [Ref-3]. In order to calculate the values for 10^{-2} p.a. return frequency, the equations and variables described in BS EN 1991-1-5:2003 and NA to BS EN 1991-1-5:2003 [Ref-3] can be applied.

(c) Envelope Condition

The conservative air temperature extremes for the envelope conditions are selected by comparing the values of (a) Candidate Site Condition and (b) General Information. The

temperature rise values caused by the climate change estimated based on UKCP09 Projection are added to the selected maximum air temperature.

The air temperature extremes for the envelope condition are shown in the Table 2.3-1.
The following SSCs are designed based on these temperatures.

- civil and structural components for normal condition
- civil and structural components for extreme condition
- emergency HVAC for extreme condition

The design temperature for normal HVAC is not included in Table 2.3-1 since it is determined based on the normal industrial practice as stated in "3) Design temperature for normal HVAC" of this section.

Table 2.3-1 : Air Temperature for Generic Site Condition

Condition	Return Frequency (per annum)	Maximum Air Temperature	Minimum Air Temperature
Normal	10^{-2}	[TBD]	[TBD]
Extreme	10^{-4}	[TBD]	[TBD]

2.3.2.3 Wind Speed

Wind speed of the Generic Site will be defined as the 3 seconds gust wind speed. Tornado will be also considered for the definition of the Wind Speed. Further evaluation for the effect of the Tornado will be carried out in Step 3.

(a) Candidate Site Condition

The maximum gust wind speed for the candidate site will be evaluated based on the historical record of the maximum gust speed at or around the candidate site.

(b) General Information

The maximum 10 minutes mean wind velocity for the Generic Candidate Sites for 50 years return period will be evaluated from NA to BS EN 1991-1-4:2005+A1:2010 [Ref-4].

In order to calculate the value for 10^{-2} p.a. return frequency, the equations and variables described in BS EN 1991-1-4:2005+A1:2010 and NA to BS EN 1991-1-4: 2005+A1:2010 [Ref-4] can be applied.

Further discussion is needed to calculate the maximum wind speed for 10^{-4} p.a. return frequency.

The 3 seconds gust wind speed will be obtained by applying some conversion factor from 10 minutes mean wind velocity. One example of the conversion factor is that derived from Figure C26.5-1 of ASCE 07-10 [Ref-5].

The detailed method will be discussed and the maximum wind speed for Generic Candidate Sites should be determined in Step 3.

(c) Envelope Condition

The conservative gust wind speed for the envelope conditions is selected by comparing the value of the (a) Candidate Site Condition, and (b) General Information. The climate change effects will be considered appropriately in the evaluation of envelope condition.

Table 2.3-2 : Gust Speed for Generic Site

Condition	Return Frequency (per annum)	Maximum Gust Speed
Normal	10^{-2}	[TBD]
Extreme	10^{-4}	[TBD]

2.3.2.4 Precipitation

The maximum precipitation for the Generic Site will be defined taking into account the historical data of the candidate site and the historical data and/or the UK practice for Generic Candidate Sites in the UK.

(a) Candidate Site Condition

The precipitation for the candidate site will be evaluated based on the historical record of the maximum rainfall at or around the candidate site.

(b) General Information

The maximum precipitation for the Generic Candidate Sites will be evaluated based on the historical data and/or the UK practice.

(c) Envelope Condition

The precipitation for envelope conditions is selected by comparing the values based on candidate site condition and Generic Candidate Sites condition. The climate change effects will be considered appropriately in the evaluation of envelope condition.

Table 2.3-3 : Precipitation for Generic Site Conditions

Condition	Return Frequency (per annum)	Maximum Precipitation
Normal	10^{-2}	[TBD]
Extreme	10^{-4}	[TBD]

2.3.2.5 Snow Load

The snow load for the Generic Site will be defined taking into account the historical data of the candidate sites and the snow load for Generic Candidate Sites based on the industrial codes and standards in the UK.

(a) Candidate Site Condition

The snow load for the candidate site will be evaluated based on the historical record of the maximum snow fall at or around the candidate site.

(b) General Information

The snow load for the Generic Candidate Sites for 50 years return period will be evaluated from NA to BS EN 1991-1-3:2003 [Ref-6]. In order to calculate the values for 10^{-2} p.a. return frequency, the equations and variables described in BS EN 1991-1-3:2003 and NA to BS EN 1991-1-3:2003 [Ref-6] can be applied.

Further discussion is needed to calculate the snow load for 10^{-4} p.a. return frequency. The detailed method will be discussed and the snow load for Generic Candidate Sites should be determined in Step 3.

(c) Envelope Condition

The conservative snow load for the envelope conditions is selected by comparing the values of the (a) Candidate Site Condition and the (b) General Information. It is considered more conservative that the climate change effects are not included in the design values of the snow loads, when the current trend of the global warming is considered.

Table 2.3-4 : Snow Load for Generic Site

Condition	Return Frequency (per annum)	Snow Load
Normal	10^{-2}	[TBD]
Extreme	10^{-4}	[TBD]

2.3.3 Hydrology

2.3.3.1 Flood Level

The flood hazard level for the extreme condition for the generic site will be defined taking into account the extreme sea levels and marine design base flood from the historical data of the candidate sites in the UK.

(a) Candidate Site Condition

The flood hazard level for the candidate site is based on the value which is their assessments, and the value is shown in the Table 2.3-5.

Table 2.3-5 : Candidate Site Condition Based on Their Assessment

Condition	Return Frequency (per annum)	Flood Hazard Level
Extreme	10^{-4}	9.78 mAOD [Preliminary]

AOD : Above Ordnance Datum

(b) General Information

Later

(c) Envelope Condition

The envelope conditions are shown in the Table 2.3-6.

Table 2.3-6 : Flood Hazard Level for Generic Site Conditions (DRAFT)

Condition	Return Frequency (per annum)	High Sea Level and Flood Hazard Level
Extreme	10^{-4}	9.78 mAOD [Preliminary]

* The value includes climate change. At the moment, the climate change scenario of 'reasonably foreseeable' is applied for the design condition from following reasons:

(i) The scenario 'reasonably foreseeable' is reasonable.

(ii) Since the climate change will occur gradually, the design change can be managed after operation of the power station commenced if needed.

2.3.3.2 Ground Level

(a) Definition of Ground Level

The standard ground level of the UK ABWR is 13.0 m AOD [Preliminary] to be appropriately higher than the extreme flood level stated in Table 2.3-6.

(b) Evaluation

The standard ground level is higher than the maximum flood level to avoid adverse effect of the external flooding.

(c) Conclusion

Site license applicants will identify the site specific ground level that is adequately higher than the site specific external flooding level.

2.3.4 Soil and Seismic Input

2.3.4.1 Soil

(a) Soil properties

The soil properties of the generic site are required to bound those of the candidate sites. Since the soil properties of hard site defined in the EUR [Ref-2] bound those of the candidate sites, the soil properties in the EUR shown in Table 2.3-7 are used for those of the generic site in the UK.

Table 2.3-7 : Soil Properties of Hard Site Defined in EUR

Type of Spectrum	Hard		
1. Shear wave velocity (m/s)	1 200	1 700	2 500
2. Mass density (kg/m³)	2 500		
3. Poisson's ratio	0,35		
4. Internal damping (%)	3		
5. Free field shear modulus Gmax (MPa)	3 600	7 225	15 625
6. Gmax beneath structures (MPa)	3 960	7 225	15 625
7. Effective G beneath structures (MPa)	3 960	7 225	15 625
8. Effective Young's modulus (MPa)	10 692	19 507,5	42 187,5

(b) Allowable bearing capacity

Average allowable static bearing capacity and maximum allowable dynamic bearing capacity demand is determined, including a factor of safety, based on the averaged bearing pressure of the footprint of the structure and the maximum bearing reaction derived from 3D analysis results under the all necessary load combinations, respectively.

(c) Liquefaction potential

Liquefaction potential will not be considered in GDA design. Evaluation of the liquefaction potential will be carried out in Site License process.

2.3.4.2 Seismic Input

The seismic design of NPP considers the effect of seismic input that corresponds to the seismic categorisation. As for Seismic Category, refer to Chapter 5.4.5 (3). Seismic inputs are defined as follows:

(a) DBE

DBE is the earthquake which covers UHS of 10^{-4} annual probability of exceedance earthquake in the candidate sites. DBE is used to evaluate SSCs which are categorised as Seismic Categories 1 and 1A.

(b) 10^{-3}/year earthquake

10^{-3}/year earthquake is the earthquake which covers UHS of 10^{-3} annual probability of exceedance earthquake in the candidate sites. 10^{-3}/year earthquake is used to evaluate SSCs which are categorised as Seismic Category 2.

(c) OBE

OBE is the earthquake which covers UHS of 10^{-2} annual probability of exceedance earthquake in the candidate sites. OBE is used to ensure that SSCs important to safety are not impaired by the repeated occurrence of ground motion at OBE level. OBE is used for seismic evaluation during plant operable condition.

The spectrum that is 1.1 times EUR hard site spectrum [Ref-2] is used for DBE. The DBE horizontal spectrum shown in Figure 2.3-2 bounds 10^{-4} / year UHS and PML spectra in the candidate sites.

The spectrum that is 0.5 times DBE is used for 10^{-3} / year earthquake and OBE [Preliminary]. 1/2 DBE bounds 10^{-3} and 10^{-2} / year UHS and PML spectra in the candidate sites [Preliminary].

In addition, two orthogonal horizontal components and a vertical component are considered for the seismic input. The vertical spectrum shown in Figure 2.3-2 was developed as the product of the corresponding horizontal spectra and a set of vertical-to-horizontal (V/H) ratios proposed by Campbell and Bozorgnia [Ref-7]. The methodology will be justified in Step 3.

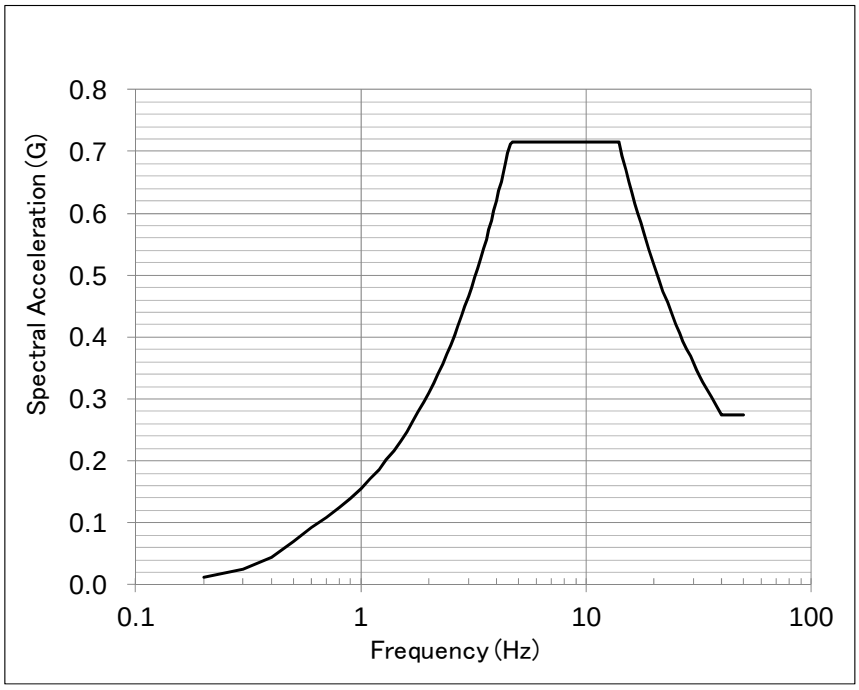

Figure 2.3-2 : Horizontal Spectrum of DBE (1.1 times EUR Hard Site Spectrum) for Generic Site

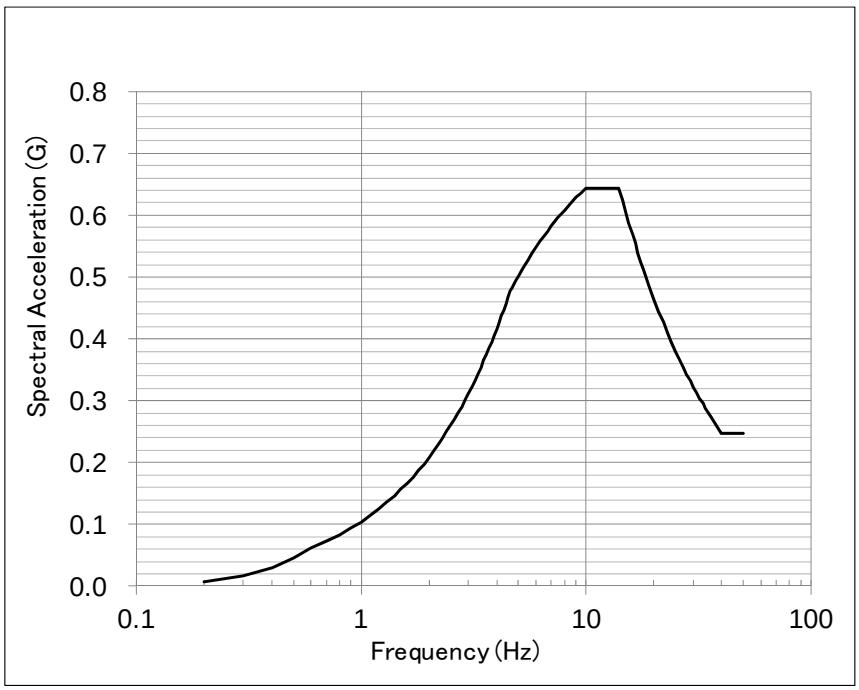

Figure 2.3-3 : Vertical Spectrum of DBE (1.1 times EUR Hard Site Spectrum) for Generic Site

2.3.5 Electrical and Grid Connections

2.3.5.1 EMI

Following items are considered as sources of EMI.

- Natural EMI sources

  Sources that are associated with natural phenomena. They include atmospheric charge/discharge phenomena such as Lightning and extraterrestrial sources including radiation from the sun (Solar Flares).

- Man-made EMI sources

  Sources associated with man-made devices such as power lines.

The magnitude of those sources for generic site will be evaluated considering hazard evaluation of candidate site.

One of the EMI source is lightning. Lightning produces transitional extremely high voltage and current which is called lightning surge. And when lightning surge occurred inside the nuclear power plant, this may produce electric field and it affects to the electric devices such as panels and instrumentations.

Event probability of the lightning is defined as [TBD] based on event probability of candidate site. The magnitude of the lightning surge is defined as [TBD] based on appropriate code and standard. Sufficient protection for the lightning surge (such as lightning arrester) will be applied to protect electrical equipment.

In terms of an appropriate standard for Lightning Protection we would anticipate that BS EN 62305 [Ref-8] would be applied.

2.3.5.2 Grid Connections

Grid Connection of the ABWR will be defined considering the grid configuration of the each site.
The condition of the grid connection will be different for each site, therefore a detailed study and coordination with the grid company will take place and an appropriate Grid connection will be defined.

A detailed description of the Grid Connection is provided within the GDA document “Preliminary Construction Safety Report on Electrical Engineering”.

2.3.5.3 Loss Of Offsite Power (LOOP)

UK ABWR in generic site should be designed by determining the following LOOP events:

- Short term LOOP of 2 hours duration 5×10^{-2}/yr [Preliminary]
- Medium term LOOP of 24 hours duration 5×10^{-3}/yr [Preliminary]
- Long term LOOP of 168 hours duration 5×10^{-5}/yr [Preliminary]

2.3.6 Other External Hazards

Additionally, following External Hazards are considered in GDA Generic Site Envelope.

2.3.6.1 Aircraft Impact

This section describes the characteristics of design consideration against the aircraft impact. Intentional aircraft impact is assessed as a Beyond-Design-Basis (BDB) event in the GDA process, and an accidental aircraft impact is assessed as a design basis event in the site licensing, according to the frequency.

2.3.6.2 External Fire

Extreme fire poses risks of the burning of parts of the plant and the resulting damage. Smoke and toxic gases may affect plant operators and certain plant systems. This section describes the characteristics of the External Fire against the nuclear power station. The design of the nuclear power station considers External Fire from site boundary of the nominated site in the UK.

2.3.6.3 External Missile

All of civil engineering structures should consider the effect of external missiles. This section describes the characteristics of design consideration against external missiles.

2.3.6.4 External Explosion

This section describes the design conditions of the Extreme Explosion. An explosion in air is accompanied by a very rapid rise in pressure and the formation of a blast wave. Design conditions of the External Explosion will be considered in civil engineering structures.

2.4 Conclusion

This section has identified the Generic Site Conditions to be included in the GDA for the UK ABWR. These conditions are summarised in Table 2.4-1.

Table 2.4-1 : Generic Site Conditions

Generic Site Conditions		
Parameter	**Definition**	**Remarks**
Heat Sink	-	
Maximum for Accident Condition Minimum for Accident Condition Maximum for Normal Condition Minimum for Normal Condition	30°C [Preliminary] -1.6°C (Sea water) [Preliminary] / 0°C (River or Cooling tower) [Preliminary] 21°C [Preliminary] 3°C [Preliminary]	
Meteorology	-	
Air Temperature	-	
Maximum for Normal HVAC Minimum for Normal HVAC Maximum Normal Condition for Civil and Structural Component Minimum Normal Condition for Civil and Structural Component Maximum for Emergency HVAC and extreme condition for Civil and Structural Component Minimum for Emergency HVAC and extreme condition for Civil and Structural Component	[TBD] [TBD] [TBD] [TBD] [TBD] [TBD]	
Wind Speed	-	
Operating Condition	[TBD]	
Extreme Condition	[TBD]	
Rain	-	
Operating Condition	[TBD]	
Extreme Condition	[TBD]	
Snow	-	
Operating Condition	[TBD]	
Extreme Condition	[TBD]	
Hydrology	-	
Flood Level	9.8 m AOD [Preliminary]	
Ground Level	13.0 m AOD [Preliminary]	
Soil and Seismic Input	-	
Shear Wave Velocity	EUR hard soil condition	
Average Allowable Static Bearing Capacity	Will be determined based on 3D analysis and load combination. [Preliminary]	

Continued

Generic Site Conditions		
Parameter	**Definition**	**Remarks**
Continued		
Electrical and Grid Connections	-	
EMI	[TBD]	
Grid Connections	[TBD]	
Loss Of Offsite Power (LOOP)	➢ Short term LOOP of 2 hours duration 5×10^{-2}/yr [Preliminary] ➢ Medium term LOOP of 24 hours duration 5×10^{-3}/yr [Preliminary] ➢ Long term LOOP of 168 hours duration 5×10^{-5}/yr [Preliminary]	
Other External Hazards	-	
Aircraft Impact	[TBD]	
External Fire	[TBD]	
External Missile	[TBD]	

2.5 References

[Ref-1] National Policy Statement for Nuclear Power Generation (EN-6)

[Ref-2] European Utility Requirements for LWR Nuclear Power Plants (EUR) Volume 2, "Generic Nuclear Island Requirements", Chapter 4, Design Basis, Rev. D, October 2012

[Ref-3] BSEN 1991-1-5:2003, "Eurocode 1: Actions on structures – Part 1-5: General actions – Thermal actions", with NA to BS EN 1991-1-5:2003, "UK National Annex to Eurocode 1: Actions on structures – Part 1-5: General actions – Thermal actions"

[Ref-4] BS EN 1991-1-4:2005+A1:2010, "Eurocode 1: Actions on structures – Part 1-4: General actions – Wind actions", with NA to BS EN 1991-1-4:2005+A1:2010, "UK National Annex to Eurocode 1: Actions on structures – Part 1-4: General actions – Wind actions"

[Ref-5] ASCE 07-10, "Minimum Design Loads for Buildings and Other Structures"

[Ref-6] BS EN 1991-1-3, "Eurocode 1 – Actions on structures – Part 1-3: General actions – Snow loads", with NA to BS EN 1991-1-3, "UK National Annex to Eurocode 1 – Actions on structures – Part 1-3: General actions – Snow loads"

[Ref-7] Bozorgnia, Y., and Campbell, K. W. (2004). "The vertical-to-horizontal response spectral ratio and tentative procedures for developing simplified V/H and vertical design spectra." Journal of Earthquake Engineering, 8(2), 175-207.

[Ref-8] BS EN 62305, "Lightning Protection Standard"