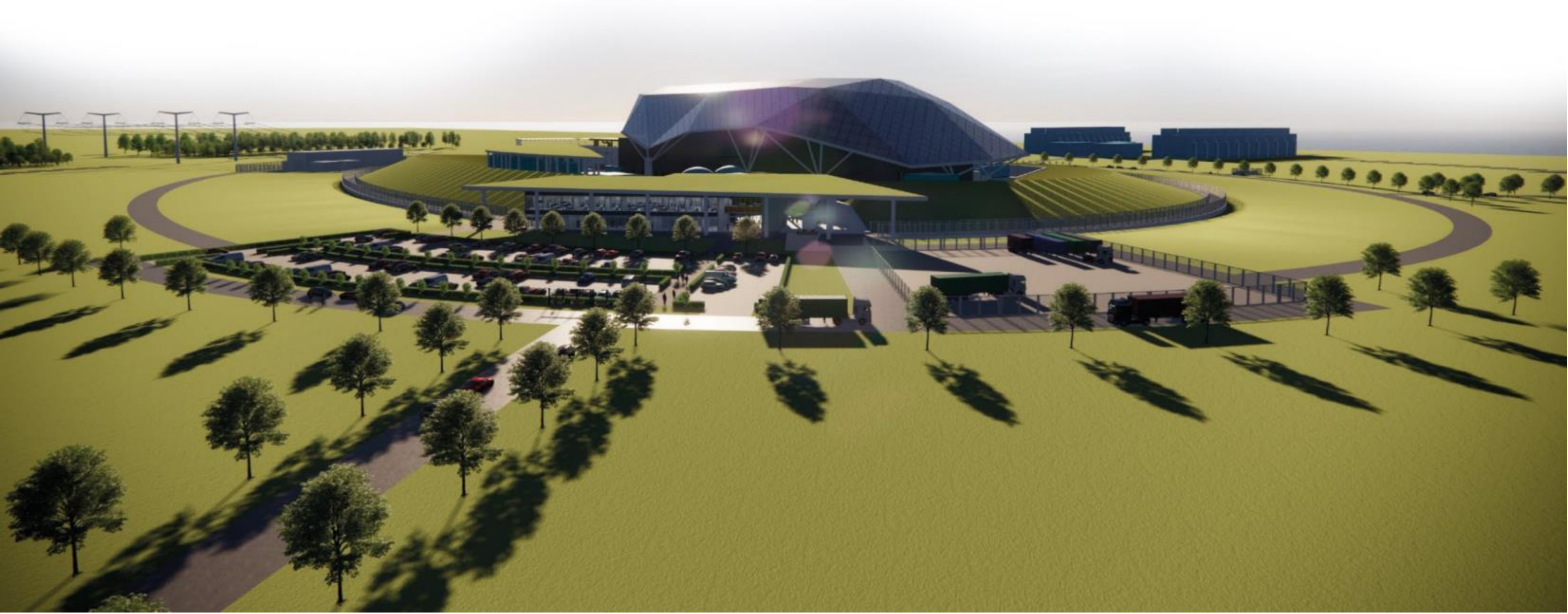
Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 2: Generic Site Characteristics



Record of Change

Date	Revision Number	Status	Reason for Change
March 2023	1	Issue	First issue of E3S Case
January 2024	2	Issue	Incorporates revised approaches defined at Reference Design 7, aligned to Design Reference Point 1, including parameters for: • Minimum seawater temperature • Rainfall rates • Seismic shear wave velocity • Accidental aircraft crash frequencies • Loss of off-site power frequencies • Bounding values for space weather induced hazards
May 2024	3	Issue	Updated to correct revision history status at Issue 2. Chapter changes include: • A summary of the external hazard parameters • Addinal description of the Atmospheric Steam Dump heat sink • Additional detail within conclusion section for how arguments and evidence presented meet the generic E3S case objective Also minor template/editorial updates for overall E3S Case consistency.

Executive Summary

This chapter presents the Great Britain (GB) generic site characteristics for the Rolls-Royce Small Modular Reactor (RR SMR) Environment, Safety, Security, and Safeguards (E3S) Case.

A set of parameters for the generic site envelope (GSE) supporting deployment in suitable locations in GB are derived to inform the design development and analysis of the RR SMR. This chapter also presents a summary of the generic site description (GSD) that has been developed to support environmental assessments.

Climate change projections up to the year 2100 have been considered in the development of parameters based on United Kingdom Climate Projections 2018 (UKCP18).

Version 2 of the generic E3S Case is developed in support of the reference design 7 (RD7) design stage, corresponding to design reference point 1 (DRP1) for the generic design assessment (GDA). This issue provides updates to the values associated with the parameters of minimum seawater temperature, rainfall rates, seismic shear wave velocity, accidental aircraft crash frequencies and loss of off-site power frequencies, as well as introducing bounding values for space weather induced hazards.

The generic site characteristics will continue to be developed to underpin the top-level claim that ‘the RR SMR is designed using bounding generic site characteristics and parameters to enable deployment in suitable locations in Great Britain’. These updates will include further consideration of combinations of external hazards or combinations of internal and external hazards, refinement of loss of off-site power (LOOP) frequencies, and any modifications to climate change projections or local population density and distribution criteria.

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2.1 Introduction

2.1.1 Introduction

Chapter 2 of the Rolls-Royce Small Modular Reactor (RR SMR) generic Environment, Safety, Security and Safeguards (E3S) Case presents the overarching summary and entry point to the Great Britain (GB) generic site envelope (GSE) for the RR SMR. It provides details of the site bounding characteristics and parameters for which the RR SMR is designed, such that it is capable of being built and operated in a way that is acceptable from a safety, environment, security and safeguards point of view throughout its entire lifecycle, wherever it is deployed in GB.

2.1.2 Scope and Maturity

The scope of this chapter is to provide a summary of the RR SMR GSE parameters [1]. These have been developed to inform the design development and analysis in support of the reference design 7 (RD7) design stage, capturing the engineering and analysis undertaken for the final concept definition, corresponding to design reference point 1 (DRP1) for the generic design assessment (GDA) process [2] and [3]. This includes:

- External hazards (section 2.2)
- Ultimate heat sink (section 2.3.1)
- Local population density and distribution (section 2.3.2)
- Connections to the electrical grid (section 2.3.3)
- Loss of off-site power (section 2.3.4)
- Soil properties (section 2.3.5)
- Generic site description (GSD) (section 2.4)

The external hazards consider only those hazards that have been identified and screened as relevant to suitable locations in GB which are generic; further site-specific characterisation of hazards will be undertaken at site licensing (captured by *Commitment on Future Dutyholder/Licensee/Permit Holder C2.2).* The hazard identification and screening process is described in section 2.2. The effects of climate change on the values of meteorological parameters have also been considered (section 2.2.3).

The consideration of heat sinks is extended to the atmospheric conditions within which the mechanical draft cooling towers would operate. The seawater make-up supply temperatures for extraction and discharge are covered within the scope of this chapter. The design can use freshwater lakes and freshwater or tidal river water providing that volume, temperature and salinity requirements are met.

The density and distribution of the local population considers the acceptability criteria only and no specific site evaluations are carried out.

The electrical grid connections cover the export of power produced by the plant as well as the import needs for various operational conditions.

Only design basis values are provided in the GSE with an exception where an operating basis earthquake value is given.

Beyond design basis events and cliff edge events have been considered at a high level (section 2.2.4).

Issue 1 of the GSE was defined to encompass a wide range of potential current and former nuclear licensed sites as well as nearby locations around coastal GB. This second issue provides updates to the values associated with minimum seawater temperature, rainfall rates, seismic shear wave velocity, accidental aircraft crash frequencies and the frequency of loss of off-site power parameters as well as introducing bounding values for space weather induced hazards. The conclusions of this chapter provide a forward look of information still to be developed for chapter 2 to achieve the generic E3S Case objective.

At the site-specific stage, the GSE will be combined with two different types of site-specific analyses. A rigorous comparison of the GSE against the characteristics of the proposed site will have to be undertaken to demonstrate that the site is bounded by the GSE criteria. The other set of analyses will be used to demonstrate the suitability of the site for external hazards that are considered to be site-specific factors in the GSE (for example: landscape changes, flooding, drought, industrial hazards, biological hazards). Multiple units on the same site are 'out-of-scope' of the GDA. These analyses are captured in the following two Commitments on the future Dutyholder/Licensee/Permit Holder:

Commitment on Future Dutyholder/Licensee/Permit Holder C2.1*: Carry out a rigorous comparison of any proposed site with the Generic Site Envelope criteria and determine if the site complies with the criteria laid down and resolve any gaps.*

Commitment on Future Dutyholder/Licensee/Permit Holder C2.2*: Carry out screening and analyses of the suitability of any proposed site against any 'out-of-scope' external hazards and site-specific factors excluded from the GSE and determine if the site is acceptable.*

The scope of this chapter also includes a summary of the GSD, section 2.4. This section includes references to the detailed environmental assessments.

2.1.3 Claims, Arguments and Evidence Route Map

The overall approach to claims, arguments, evidence (CAE) and the set of fundamental E3S claims to achieve the E3S fundamental objective are described in E3S Case Version 2, Tier 1, Chapter 1: Introduction [4]. The associated top-level chapter claim for E3S Case Version 2, Tier 1, Chapter 2: Generic Site Characteristics is:

Claim 2: The RR SMR can be constructed, operated and decommissioned in suitable locations in Great Britain in a way that is safe, secure and that protects people and the environment.

A decomposition of this claim into sub-claims, arguments, and link to the relevant Tier 2 and Tier 3 evidence is presented in the E3S Case Route Map [5]. Given the evolving nature of the E3S Case alongside the maturing design, the underpinning arguments and evidence may still be developed in future design stages; the trajectory of this information, where possible, is also illustrated in the route map, which aligns the anticipated arguments and evidence to future versions of the generic E3S Case (subject to ongoing planning).

A proportionate summary of the arguments and evidence from lower tier information, available at the current design stage, RD7/DRP1, is presented within this chapter. A mapping of the claims to the corresponding sections that summarise the arguments and/or evidence is provided in Appendix A (section 2.6).

2.2 External Hazards

2.2.1 Method for Identification and Analysis of External Hazards

External hazards for RR SMR are identified by:

- applying hazard identification methods
- reviewing documents issued by nuclear licensing bodies
- reviewing previous GDA submissions to the Office for Nuclear Regulation (ONR).

Full details of the hazard identification methods employed and the reference materials reviewed are contained in 'RR SMR GB Generic Site Envelope' [1].

The external hazards that are identified are then screened. The screening is designed to remove those hazards that are:

- not relevant for a site in GB
- of low frequency (estimated to be less than a frequency of one in ten million years)
- of low consequence (no significant consequential effect on the safety of the plant)
- are covered by another hazard such that they could be grouped together.

Full details of the screening methods employed are contained in 'RR SMR GB Generic Site Envelope' [1].

Values for the various parameters are developed based on relevant good practice (RGP) and operational experience (OPEX). Full details of the development of parameters are contained in 'RR SMR GB Generic Site Envelope' [1]. Climatology modelling, beyond design basis and cliff edge effects are discussed in sections 2.2.3 and 2.2.4.

2.2.2 Hazard Screening

The external hazards with parameters defined at this issue of the generic site characteristics are:

- Air temperature
- Relative humidity
- Wind
- Tornado
- Tornadic missiles
- Rainfall

- Hail, sleet and snow
- Ice
- Cooling water temperature
- Lightning.

There are a number of external hazards which have site specific elements. These include:

- Seismic acceleration and shear wave velocity
- Accidental aircraft crash
- Landscape changes
- Space weather
- Flooding
- Drought
- Industrial
- Biological.

The GB GSE [1] provides reassurance and mitigation measures for how these hazards will be dealt with (apart from landscape changes [6] and drought). High and low water table levels, induced by excessive rainfall or drought, will be accounted for using appropriate civil engineering design codes, such as those published by European Utilities Requirements (EUR) [7]; this is described further in E3S Case Version 2, Tier 1, Chapter 9B: Civil Engineering Works and Structures [8].

2.2.3 Climate Change

Climate change values up to the year 2100 have been calculated using the UK Climate Projections 2018 (UKCP18) climate analysis tool [9]. If a parameter cannot be modelled using UKCP18 then best available data are used.

Climate change is known to affect the following parameters [1]:

- Air temperature
- Rainfall intensity
- Seawater temperature
- Wind speed
- Storm frequency and lightning
- Snow loading and drifting
- Humidity.

UKCP18 uses representative concentration pathways (RCPs) to develop climate change predictions. RCPs specify the concentrations of greenhouse gases that will result in the total radiative forcing increasing by a specified amount by 2100, relative to pre-industrial levels. RCP 6.0 scenario uses a high greenhouse gas emissions rate and the 90th percentile is used to examine values. If there is no data for RCP 6.0 provided in UKCP18 for a particular parameter then RCP 8.0 at the 50th percentile is used.

Climate change adjustment factors are taken into account for air temperature, wind speed, rainfall intensity and seawater temperature parameters. Full details of the base data, the climate change adjustment factors and how these are taken into consideration are given in the GB GSE report [1].

Modelling of climate changes' influences on storm frequency and lightning strike density is inconclusive at the current time and further research is necessary [1]. No climate change adjustment factors are applied to the snow loading as the climate is expected to warm and the current values are considered to be conservative [1]. Relative humidity values are set as conservative but do not have any specific climate change adjustment factors applied [1].

Further climate refinement models will be developed in the future and adaptive management techniques employed by the Dutyholder to ensure that the operation of the plant remains safe beyond the year 2100. This is captured as a commitment on the future Dutyholder/Licensee/Permit Holder:

Commitment on Future Dutyholder/Licensee/Permit Holder C2.3: Develop further climate refinement models and employ adaptive management techniques to ensure that the operation of the plant remains safe beyond the year 2100.

2.2.4 Beyond Design Basis and Cliff Edge Effects

The determination of the severity of the design basis event for external hazards varies dependent on whether it is man-made or naturally occurring.

For human-made external hazards the design basis is defined in one of two ways: probabilistically, as a best estimate value of hazard severity and frequency of occurrence down to 1E-5/year, or deterministically, as a maximum credible event [10].

For natural external hazards defined by hazard curves, the design basis is defined as follows: probabilistically, as a conservative estimate of hazard severity at the 1E-4/year frequency of exceedance point on the hazard curve [10].

The term 'beyond design basis external event' is used to indicate a level of external hazard exceeding those hazard levels considered for design, derived from the hazard evaluation for the site. The purpose of identifying beyond design basis external events is to ensure that the design incorporates features to enhance the capability of the installation to withstand such events. In addition, the identification of such events is used in evaluating the margins that exist in the design and in identifying potential cliff edge effects. The beyond design basis studies for external hazards will use and support the probabilistic safety analyses and severe accident analyses.

A cliff edge is defined as "where a small change in analysis assumptions, such as those relating to design basis hazard severity, facility response, or design basis analyses is predicted to lead to a disproportionate increase in radiological consequence" [10]. The cliff edge evaluation is to demonstrate that the plant design is robust to uncertainties in the definitions of external hazard design.

The exact challenge the plant is subjected to cannot be determined until the site is known. For some criteria hazard curves will need to be generated for example seismicity. The philosophy behind the RR SMR design is that bounding values have been used for all hazards. Therefore, it is anticipated that as conservative values have been used to encompass a wide range of sites that there will be a margin between the design values and the site-specific requirements. This margin will be explored as the design and GDA progress with sensitivity studies to show that there are no cliff edge effects and there is adequacy beyond the design basis.

A methodology to determine the beyond design basis response of the plant is being prepared and will be used to provide information on the margins available.

To show resilience from cliff edge effects the structure of the plant particularly the hazard shield will be designed elastically with ductile detailing allowing a margin for many of the external hazards. For studies beyond the design basis, the probabilistic safety assessment will be used to establish what failure modes can occur and how the plant safety functions that will be challenged.

2.2.5 Air Temperature

The ambient air temperature values are defined for the bounding maximum and minimum values for the lifetime of the plant [1]. The enthalpy of the air affects the heat transfer to the atmosphere which is used as the ultimate heat sink. Low temperatures affect the fluids such as water and diesel as they can freeze or wax-up pipes affecting cooling and standby power generation.

The temperatures have been derived from measured values at GB sites likely to host nuclear power stations and then conservative climate change factors added to the base values [1].

The value chosen for the maximum hourly dry bulb air temperature is 49.0 ˚C.

The value chosen for the maximum hourly wet bulb air temperature is 32.3 ˚C.

The minimum dry air hourly average temperature is -35 ˚C.

Table 2.2-1 provides a summary of the air temperature criteria.

Table 2.2-1: Air Temperature Criteria

Parameter	**GB GSE Value**
Maximum dry bulb air temperature (hourly)	49.0 ˚C
Maximum wet bulb air temperature (hourly)	32.3 ˚C
Minimum dry bulb air temperature (hourly)	-35 ˚C

2.2.6 Relative Humidity

Extremes of relative humidity have been considered. Whilst it may be possible in some circumstances for supersaturation to be a phenomenon, this is discounted from being a significant issue. Therefore, the maximum relative humidity is set at 100 % [1]. The hazards associated with fog, freezing fog and mist are all considered to be within this classification.

The minimum relative humidity value is selected as 12 % [1]. Whilst humidity is discussed in UKCP18 [9] no climate change adjustment is necessary as the minimum humidity value is for a 100 % design basis envelope. The average relative humidity is selected as 84 % [1]. The upper bounding value is set at the maximum practical value and the lower bounding value is conservative.

Table 2.2-2 provides a summary of the relative humidity criteria.

Table 2.2-2: Relative Humidity Criteria

Parameter	GB GSE Value
Maximum relative humidity	100 %
Minimum relative humidity	12 %
Average relative humidity	84 %

2.2.7 Wind

Wind imposes structural loads and slender structures, such as masts, can vibrate with vortex shedding. These loads may be direct force, or if a difference in wind speed exists around buildings then pressure differences can occur.

The wind speeds under consideration in the design of the plant include a maximum ten-minute average wind speed of 46.5 metres/second [1], as shown in Table 2.2-3. It should be noted that this value is bounded by the peak wind value for a tornado. The ten-minute average is determined in accordance with the Eurocode 1 design standard [11] and is considered to be relevant good practice.

Table 2.2-3: Wind Criterion

Parameter	GB GSE Value
Maximum ten-minute average wind speed	46.5 m/s

2.2.8 Tornado

Tornado strikes pose a peak wind speed and pressure difference hazard. The peak wind speed imposes significant structural loads in excess of conventional wind loads. The rate of pressure drop and the maximum pressure drop associated with the passage of a tornado can affect positive pressure areas of the plant, such as the main control room, by overcoming door seals and the heating, ventilation and air conditioning capacity.

An evaluation of tornadoes in Britain has been carried out by Meaden [12]. That study proposed lower values than have been adopted for the RR SMR. The Met Office has produced a UKCP storm projection technical note [13] which concludes that there are no clear trends, suggesting that the impact of climate change on tornadoes is unknown. Therefore, climate change adjustment values are not applied to tornado parameters.

The United Kingdom T5 tornado classification [14] has been adopted as relevant good practice and is conservative with respect to the values published by Meaden and the European Utilities Requirements. It is consistent with the United States Nuclear Regulatory Commission (US NRC) region III tornado [15]. The peak wind speed within the region III tornado is 72 metres/second [15].

The static air pressure variations tend to be relatively small over time. Rapid transients occur during tornadoes and lower wind speed storms. For a region III tornado, the maximum rate of static pressure drop is set as 13 mbar/s and a maximum pressure drop trough value of 40 mbar [15]. The US NRC values have been used as these exceed the British T5 values. Therefore, these values are considered to be conservative. Table 2.2-4 presents a summary of the wind and tornado wind speed and pressure variations.

Table 2.2-4: Tornado Criteria

Parameter	**GB GSE Value**
Tornadic wind speed	72 m/s
Maximum pressure drop	40 mbar
Pressure drop rate	13 mbar/s

2.2.9 Tornadic Missiles

Impacts from external missiles could occur from off-site explosions. High inertia rotating machinery, such as steam turbines, could disintegrate and provide significant mass and energy missiles. Disintegration of transport infrastructure, such as pipelines, ships and trains could also provide a source of missiles. Wind-blown debris may impact the plant or block inlets and exhaust pathways. All of these are considered to be site-specific issues.

The only generic site envelope missile criteria that have been adopted are those generated by region III tornadoes [15]. This is consistent with the conservative assumption that a T5 tornado would strike the plant and conforms to relevant good practice [1]. Debris carried by a T5 tornado can include missiles such as pipe and other steel objects. Small cars can be lifted and thrown out of the rotational wind such that they could strike buildings or other exposed infrastructure. The tornadic missile criteria are shown in Table 2.2-5.

Table 2.2-5: Tornadic Missile Criteria

Type of Missile	**GB GSE Values**		
	Dimensions	**Mass (kg)**	**Impact Speed (m/s)**
Schedule 40 Pipe	0.168 m diameter x 4.58 m length	130	24
Vehicle	4.5 m x 1.7 m x 1.5 m	1178	24
Solid Steel Sphere	0.0254 m diameter	0.0669	6

2.2.10 Rainfall

Various forms of precipitation are recognised as being a hazard. Rain, sleet, snow and hail stones falling onto the plant as well as icing accumulating on the plant are recognised as having structural and pluvial flooding effects.

The rainfall for three different time intervals (15 minutes, one hour and 24 hours) are derived [1]. The values have been derived from previous GDA submissions or EUR standards [7] with appropriate climate change adjustment factors and are considered to represent relevant good practice. The values are peak rainfall rate of 0.2031 metres in 15 minutes, a one-hour peak rainfall rate of 0.2292 metres in one-hour and a 24-hour average rainfall rate of 0.400 metres in a 24-hour period. Table 2.2-6 presents a summary of the rainfall criteria.

Table 2.2-6: Rainfall Criteria

Parameter	GB GSE Value
Rainfall in 15 minutes	0.2031 m
Rainfall in one hour	0.2292 m
Rainfall in 24-hours	0.400 m

2.2.11 Hail, Snow and Sleet

Hail, snow and sleet loading on buildings are compared for structural load design purposes [1]. Snow presents the worst-case structural loading of the three types of precipitation. The maximum structural snow loading is taken to be 1.5 kN/m^2, as shown in Table 2.2-7. This value is greater than the value of 1.3 kN/m^2 which is derived from Eurocode BS EN 1993-3-1 [16] and its National Annex [17]. No climate change adjustment has been made as global warming is expected to increase the temperature which would lead to a reduction in ice formation. The values presented are assumed to be conservative on that basis.

Table 2.2-7: Ground Snow Load Criteria

Parameter	GB GSE Value
Ground snow load	1.5 kN/m^2

2.2.12 Ice

Clear ice, rime ice and glaze ice are compared for structural load design purposes [1]. Clear ice presents the worst-case structural loading of the three types of ice. The evaluation of ice thickness and density is derived from Eurocode BS EN 1993-3-1 [16] and its National Annex [17]. No climate change adjustment has been made as global warming is expected to increase the temperature which would lead to a reduction in ice formation. The values presented are assumed to be conservative on that basis.

The maximum thickness of clear ice that would accumulate at the plant is estimated to be a depth of 0.1171 metre.

The density of the clear ice is taken to be 9 kN/m^3.

Table 2.2-8 presents a summary of the clear ice bounding values.

Table 2.2-8: Ice Loading Criteria

Parameter	**GB GSE Value**
Clear ice density	9 kN/m^3
Clear ice thickness	0.1171 m

2.2.13 Cooling Water Temperature and Salinity

If the temperature drops sufficiently then the possibility of the water used as make-up might freeze. If the temperature of the water is excessive then inadequate cooling may be available for the plant to operate at peak output power.

The town water supply (or potable water supply) is used to feed the make-up of the essential service water system (ESWS) [PB]. The maximum temperature is set at 30 ˚C and the minimum water temperature is set at 0 ˚C. These values are taken from the European Utilities Requirements [7] and represent relevant good practice.

The seawater supply temperature is set at a maximum of 32.3 ˚C. This is based on stress test values for existing plants and the addition of a climate change adjustment factor. Therefore, this value represents relevant good practice. The minimum temperature is set at -1.8 ˚C in order to avoid frazil ice related hazards. However, frazil ice formation will have to be considered on a site-specific basis in order to account for local salinity levels, and other factors [1].

The maximum salinity of seawater taken into the plant is set as 3.5 %.

No values are set at GDA for water taken from lakes or rivers for use in the main cooling water system or the auxiliary cooling and make-up system. Further details of these systems are given in section 2.3.1.

A summary of the cooling water temperature and salinity values are stated in Table 2.2-9.

Table 2.2-9: Cooling Water Temperature and Salinity Criteria

Parameter	**GB GSE Value**
Town water supply maximum temperature	30 ˚C
Town water supply minimum temperature	0 ˚C
Maximum seawater temperature	32.3 ˚C
Minimum seawater temperature	-1.8 ˚C

Parameter	GB GSE Value
Maximum salinity of seawater	3.5 %

2.2.14 Lightning

Lightning strikes pose an electrical shock hazard to workers as well as to equipment and buildings. The hazard can be managed by using appropriate design codes for workers inside buildings as well as for the equipment and buildings. Workers outside buildings need to seek shelter for the duration of the thunderstorm's passage near the site.

The British standard [18] and the European Utilities Requirements [7] specify a lightning strike peak current value of 200 kA. CIGRE gives a value of 300 kA [19]. This bounding value has been adopted as a conservative value.

The value for the lightning peak current parameter used is shown in Table 2.2-10.

Table 2.2-10: Lightning Strike Criterion

Parameter	GB GSE Value
Lightning peak current	300 kA

2.2.15 Seismic

The seismic hazard is that of an inappropriate structural response of the plant to the disturbance. This may include excessive displacement severing the connections between reactor island and turbine island or localised hazards within components such as sloshing loads and liquid levels within a tank.

Seismic criteria are set in terms of the operating basis earthquake (OBE) and the design basis earthquake (DBE). The OBE level is defined such that no structure, system or component (required to perform an E3S function) should be impaired by the repeated occurrence of ground motions at that level [10]. The derivations of the values are given in Reference [1].

The OBE has a peak ground acceleration (PGA) value of 0.08 g [1] and [20].

The DBE has a PGA value of 0.30 g. The spectra shapes have been developed from the EUR spectrum [7] enhanced for the vertical spectrum at certain frequencies [21]. The value selected exceeds the EUR value of 0.25 g and is conservative.

The spectra shapes are shown in Figure 2.2-1 and Figure 2.2-2.

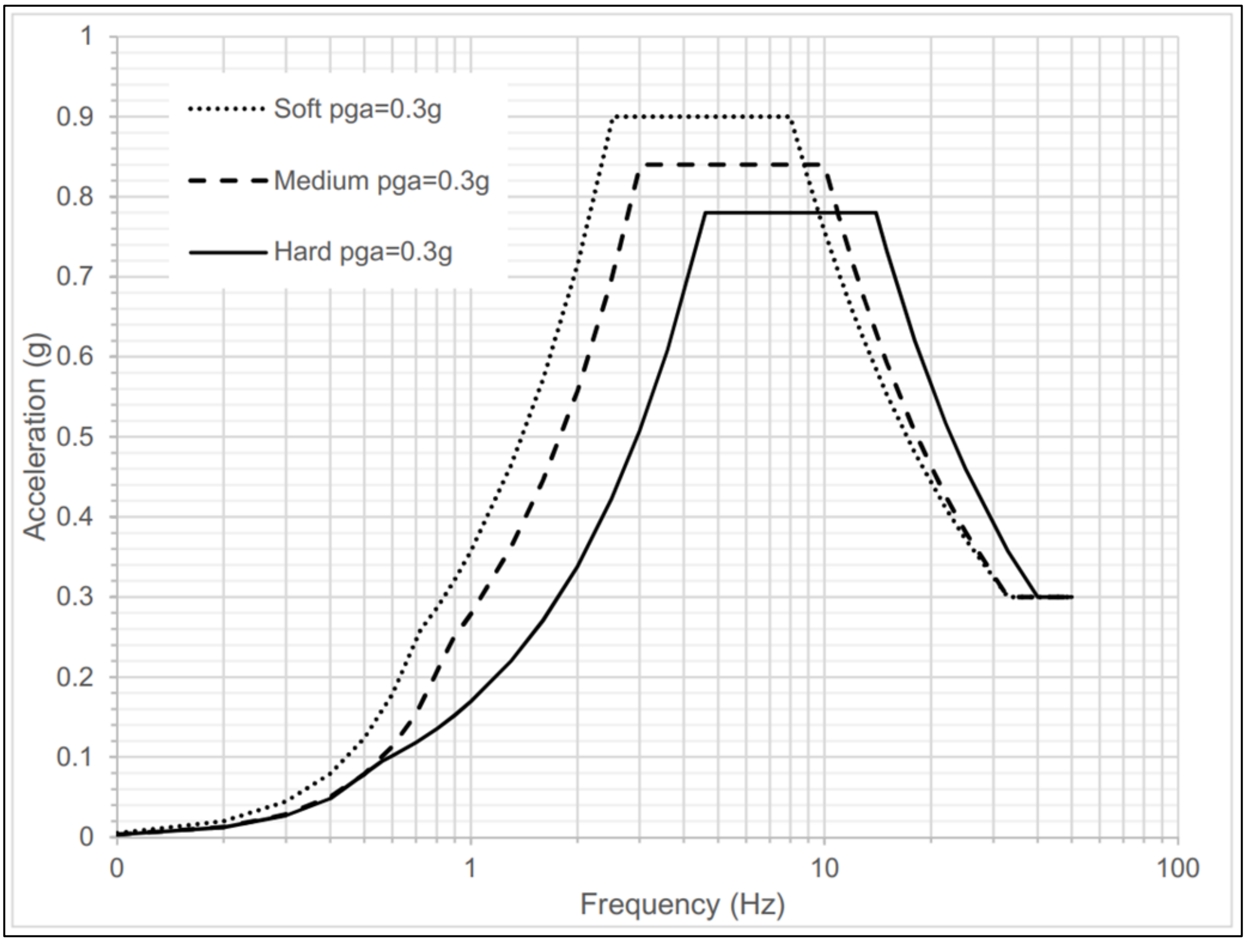

Figure 2.2-1: Adopted Horizontal Design Basis Earthquake Spectra

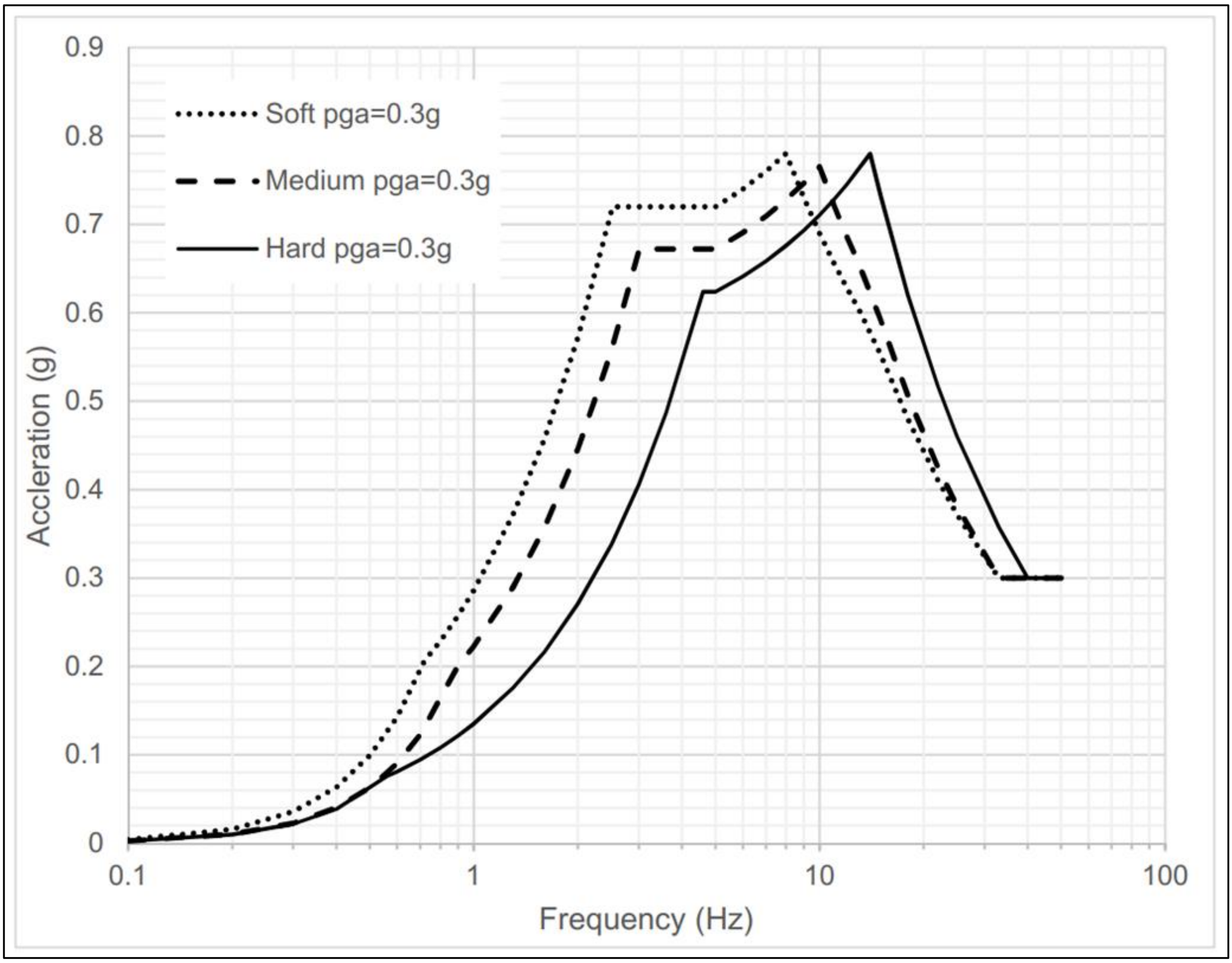

Figure 2.2-2: Adopted Design Basis Earthquake Vertical Spectra

The basic seismic criteria for earthquakes are presented in Table 2.2-11.

Table 2.2-11: Seismic Criteria for Earthquakes

Parameter	GB GSE Value
Operating basis earthquake	0.08 g (peak ground acceleration)
Design basis earthquake	0.30 g (peak ground acceleration)

2.2.16 Shear Wave Velocity

Shear wave velocity is a dynamic property of rock. The value adopted for the site is considered to be such that it excludes these ground performance hazards [1].

The assumed shear wave velocity range is between 400-1700 m/s for the sites in GB.

The shear wave seismic criterion is presented in Table 2.2-12.

Table 2.2-12: Shear Wave Velocity Criterion

Parameter	GB GSE Value
Shear Wave Velocity	400-1700 m/s

2.2.17 Accidental Aircraft Crash

An aircraft crash into the site has the potential to damage infrastructure from the kinetic energy of the aircraft itself, or its components, as well as triggering a fire from the fuel carried on-board. A hazard shield is provided to protect the Reactor Island. The hazard shield does not extend over the whole of the Reactor Island and critical equipment sited outside the hazard shield is separated and segregated in accordance with relevant good practice.

Two different causes of aircraft accident are considered in the design of the hazard shield. These are an accidental aircraft crash and a malicious aircraft crash.

The background accidental aircraft crash frequency for a generic site in GB has been evaluated [22] and [23]. The accidental crash frequency for various classes of aircraft and the combined total value is given in Table 2.2-13.

Table 2.2-13: Values Used to Calculate the Critical Area Impact Frequency

Aircraft type	Mean Accident Rate (E-6 per square kilometre per year)	Effective Target Area (square kilometres)	RR SMR Critical Area Impact Frequency (E-6 per year)
Light	10.14	0.04	0.4058
Helicopter	8.32	0.04	0.3327
Small transport	0.79	0.04	0.0316
Large transport	0.46	0.06	0.0275
Military combat	5.93	0.06	0.3557
Total	25.61	Not applicable	1.153

The number of significant figures quoted in the table exceeds the implied accuracy and precision of the results. Therefore, the mean accidental aircraft crash rate onto the critical area of a RR SMR site was considered to be occurring with a frequency of less than 1.2E-6 per year.

Site-specific calculations will be carried out for GB sites when the specific sites for deployment have been identified.

The malicious aircraft impact case [24] bounds the accidental aircraft crashes [22]. The representative aircraft types, their mass at impact, impact velocity (speed, direction and angle of travel just prior to impact) and resulting load-time graphs are security classified as Official-Sensitive: Sensitive Nuclear Information for the design of the RR SMR. For this reason, no further data are provided in this chapter.

2.2.18 Space Weather

The space weather methodology has been developed for the assessment of the space weather hazard [25]. The methodology has identified the space weather hazards which have the possibility of impairing the performance of structures, systems, and components (SSCs). Those considered include:

- Geomagnetically induced currents (GIC) (section 2.2.18.1)
- Ground level enhancements (GLE) of solar energetic particles (SEP) (section 2.2.18.2)
- Solar radio bursts (section 2.2.18.3)

Bounding values are provide however the factors influencing the effects on a nuclear plant are site -specific and will require further consideration once the site is known.

2.2.18.1 Geomagnetically Induced Currents

Solar flares and coronal mass ejections (CMEs) can produce large geomagnetically induced currents. This can lead to transformer damage, voltage instability and harmonics triggering protective relays. These effects can all result in loss of off-site power (LOOP). The site-specific hazard values that help define an event are the latitude of the site, the ground conductivity profile and distance from the coast.

A generally accepted benchmark for an extreme space weather event is the Carrington event of 1859 which is named after the British Astronomer Richard Carrington who observed a huge solar flare the day before the storm. The GIC hazard level for the geomagnetic field produced by a severe space weather event can be estimated by scaling ground level magnetic field time-series from modern magnetometer measurements of previous severe CME events to the level expected for an event on the required return-period. A theoretical upper limit for the disturbance storm time index of −2,500 nT for the largest geomagnetic storm possible presented is used for a 10,000-year event [26].

National Grid are aware of the issue surrounding GICs and are modifying networks to alleviate the hazard. The issue will be discussed between the National Grid and the plant to ensure that the problem is mitigated.

The concern can be also alleviated by suitably specified transformers which are resistant to the effects of GIC. Protection and control equipment with configurations taking account of GIC events, for example GIC blocking devices, can be used.

2.2.18.2 Ground Level Events

Significant uncertainty exists regarding the ground level neutron flux during an extreme GLE event. For short return period events, historical data is available from ground-level sensors and instruments on spacecraft, but for longer return periods data is more uncertain as it is derived from geological information, such as ice cores.

The site-specific factors influencing GLE include the geomagnetic latitude of the site, the construction of the facility building and the location of the equipment in the building. Semiconductors in plant are at risk including those in power applications, microprocessors and memory modules.

A scale of GLE intensity based on the largest GLE event of modern times (the February 1956 event) has been established by Dyer et al [27]. This was used to establish a figure for the 10,000 year return period giving a total neutron fluence of 540000 neutrons/cm^2.

The effects of GIC can be mitigated by shielding of control and instrumentation and electrical SSCs within concrete structures (for example, the hazard shield). Physical separation of controls and instrumentation systems and diversity of equipment can also be used. De-rating of power semiconductor devices can significantly reduce the probability of failure.

2.2.18.3 Solar Radio Bursts

Solar radio bursts (SRBs) are radio-frequency emissions at natural plasma frequencies. These drop through the frequency spectrum as the solar plasma from flares and CMEs expand away from the Sun. As the frequency of emission passes through bands used for different telecommunications systems, the resulting radio-frequency interference (RFI) may disrupt those services, causing reduced performance or complete loss of service (LoS). Global navigation satellite systems (GNSS) are particularly vulnerable to this type of interference as the signal strength is relatively weak at the Earth’s surface. This not expected to be a particular issue for the safety performance of the RR SMR.

2.2.18.4 GSE Values for Space Weather

The values quoted in sections 2.2.18.1 and 2.2.18.3 are bounding values only. These values are not GSE values.

2.2.19 Combination of Hazards

The study of the reasonably foreseeable combinations of external hazards as well as combinations of external and internal hazards is required (for example, [6] and [10]).

The methodology for such a study has been published in the External Combined Hazard report [28]. The output of this methodology is a series of credible external hazard combinations. The credible external hazards are given in three distinct sets: individual hazards, combined hazard scenarios and credible hazard, which are detailed in [28]. Table 2.2-14 provides a summary of the screened in combined hazard scenarios and the individual hazards that comprise each scenario.

Table 2.2-14: Summary of Hazard Scenarios

#	Hazard Scenario	Parameter
A	Cold Weather	Low Dry Bulb Air Temperature
		Humidity
		Lightning
		Rain (including pluvial flooding)
		Hail/Snow/Ice
		Wind
		Low Air Pressure
		LOOP

		Loss of Offsite Water
B	Hot Weather	High Dry Bulb Air Temperature
		High Wet Bulb Air Temperature
		Humidity
		Drought
		Lightning
		Rain (including pluvial flooding)
		Hail/Snow/Ice (Note Hail specifically)
		Sand/Dust Deposits and Volcanic Ash (Note Sand/Dust Deposits specifically)
		Wind
		Natural Fire
		LOOP
		Loss of Offsite Water
C	Storm (including coastal, fluvial flooding)	Flooding (coastal and fluvial)
		High Dry Bulb Air Temperature
		Low Dry Bulb Air Temperature
		High Wet Bulb Air Temperature
		Humidity
		Lightning
		Rain (including pluvial flooding)
		Hail/Snow/Ice
		Wind
		Low Air Pressure
		Manmade Explosions
		Manmade Fire
		Manmade Missiles
		Toxic and Corrosive Materials
		Electromagnetic Interference (EMI)/ RFI
		LOOP
		Loss of Offsite Water
D	Earthquake	Seismic Activity
		Tsunami
		Manmade Explosions

		Manmade Fire
		Manmade Missiles
		Toxic and Corrosive Materials
		EMI/RFI
		LOOP
		Loss of Offsite Water
E	Solar Activity	Manmade Fire
		EMI/RFI
		Solar GIC
		GLE
		SRBs
		LOOP
		Loss of Offsite Water
F	Tornadic Storm	High Dry Bulb Air Temperature
		Low Dry Bulb Air Temperature
		High Wet Bulb Air Temperature
		Humidity
		Lightning
		Rain (including pluvial flooding)
		Hail/Snow/Ice
		Wind
		Low Air Pressure
		Tornado
		Manmade Explosions
		Manmade Fire
		Manmade Missiles
		Toxic and Corrosive Materials
		EMI/RFI
		LOOP
		Loss of Offsite Water
G	Accidental Aircraft Impact (including consequential hazards)	Natural Fire
		Accidental Aircraft Crash
		Manmade Explosions
		Manmade Fire

		Manmade Missiles
		Toxic and Corrosive Materials
		EMI/RFI
		LOOP
		Loss of Offsite Water
H	Industrial Accident and Fire	Natural Fire
		Manmade Explosions
		Manmade Fire
		Manmade Missiles
		Toxic and Corrosive Materials
		EMI/RFI
		LOOP

2.2.20 Summary of External Hazards Parameters and GSE Values

A summary of the external hazard parameters is given in Table 2.2-15.

Table 2.2-15: Summary of External Hazard Parameters and GB GSE Values

External Hazard	Parameter	GB GSE Value
Air Temperature	Maximum dry bulb air temperature (hourly)	49.0 ˚C
	Maximum wet bulb air temperature (hourly)	32.3 ˚C
	Minimum dry bulb air temperature (hourly)	-35 ˚C
Relative Humidity	Maximum relative humidity	100 %
	Minimum relative humidity	12 %
	Average relative humidity	84 %
Wind	Maximum 10-minute mean wind speed	46.5 m/s
Tornado	Tornadic wind speed	72 m/s
	Maximum pressure drop	40 mbar
	Pressure drop rate	13 mbar/s
Tornadic Missiles	Schedule 40 pipe 0.168 m diameter x 4.58 m length, 130 kg	24 m/s
	Vehicle 4.5 m x 1.7 m x 1.5 m, 1178 kg	24 m/s
	Solid steel sphere	6 m/s

External Hazard	**Parameter**	**GB GSE Value**
	0.0254 m diameter, 0.0669 kg	
Rainfall	Rainfall in 15 minutes	0.2031 m
	Rainfall in one hour	0.2292 m
	Rainfall in 24-hours	0.400 m
Hail, Snow and Sleet	Ground snow load	1.5 kN/m^2
Ice	Clear ice density	9 kN/m^3
	Clear ice thickness	0.1171 m
Cooling Water Temperature	Maximum towns water supply temperature	30 ˚C
	Minimum towns water supply temperature	0 ˚C
	Maximum seawater temperature	32.3 ˚C
	Minimum seawater temperature	-1.8 ˚C
	Salinity concentration	3.5 %
Lightning	Lightning current	300 kA
Seismic	Design basis earthquake peak ground acceleration	0.30 g
	Operating basis earthquake peak ground acceleration	0.08 g
	Shear wave velocity	400-1700 m/s
Space Weather	All	Not applicable, only bounding values have been derived.

2.3 Site Information

2.3.1 Ultimate Heat Sink

Waste heat is removed from the power station to the atmosphere, as the ultimate heat sink (UHS) using three different systems. The heat associated with the steam power cycle passes through the condensers on the turbine island where the heat is exchanged with to the Main Cooling Water System (MCWS) [PA]. The MCWS [PA] exchanges the heat to atmosphere via mechanical draft cooling towers. The system is a closed system containing two trains with associated main circulation pumps.

The make-up water is provided by the Auxiliary Cooling and Make-up System (ACMS) which takes water from the sea (or river or lake), filters and treats the water before providing it as make-up water to counter the evaporative losses. The ACMS also provides and removes cooling water from the Turbine Island Closed Cooling Water System heat exchanger(s) and returns all of the wastewater to the sea.

The MCWS and ACMS are closed systems in the basic design for coastal sites. However, these systems can be modified to be direct cooling or indirect cooling to suit the actual location or a change in water supply from seawater to water taken from a river or lake.

The Essential Services Water System (ESWS) [PB] removes heat from the power station using the atmosphere as the UHS. The Component Cooling System (CCS) takes heated water via heat exchangers from the reactor systems directly to the ESWS. Here it is cooled by passing through closed mechanical draft cooling towers, where the water is sprayed over an internal heat exchanger to remove the heat. The CCS and ESWS have two trains which are interconnected and have isolating valves. During normal operation only one train is needed however during cooldown two trains are used to speed up cooldown and in accident conditions a single train can provide sufficient cooling. These cooling towers are not associated with the MCWS cooling towers.

The local Ultimate Heat Sink (LUHS) provides decay heat removal in support of safety measures Passive Decay Heat Removal (PDHR), Emergency Core Cooling (ECC), and In-vessel retention (IVR). The system consists of three trains, each containing an LUHS tank and its associated ancillary equipment. The coolant from the reactor is transferred to the LUHS tanks following initiation of an emergency shutdown. The water in the tanks is heated up by the incoming steam or water from the reactor. The water in the tanks will start to evaporate and transfer the decay heat to atmosphere.

Additional heat sink is incorporated in the design providing diversity and risk reduction through the provision of Atmospheric Steam Dump (ASD) [LBK50], which provides decay heat removal to the atmosphere via the SGs.

Further detailed descriptions of the design of the MCWS [PA], ACMS [PE] and ESWS [PB] are given in E3S Case Version 2, Tier 1, Chapter 9A: Auxiliary Systems [29]. Further detailed description of the LUHS [JNK] and ASD [LBK50] is given in E3S Case Version 2, Tier 1, Chapter 6: Engineered Safety Features [30].

The values selected as the design basis for the atmospheric properties of the ultimate heat sink are stated in Table 2.2-1 and Table 2.2-2. The range of seawater extraction temperatures are stated in Table 2.2-9.

The values for temperature and humidity match the general values stated for external hazards and are valid for all aspects of the plant. These values are valid for the three systems that use the indirect cooling towers as well as the LUHS that vents to atmosphere. There are no stated limits as to the temperature and humidity rise that can be tolerated by the atmosphere in the vicinity of the plant associated with using air as the ultimate heat sink.

2.3.2 Local Population Density and Distribution

To understand the number of people who could receive an off-site dose, the density and distribution of the local population should be determined. Consideration of discharges is therefore a site-specific matter. It is noted that the majority of EN-6 sites [31] and [32] have populations labelled as ‘semi-urban’ [33], which makes them suitable for the siting of a nuclear power plant. Additionally, the EN-6 sites have had previous nuclear installations close by and therefore emergency arrangements have been previously formalised. At the site-specific stage, the emergency Preparedness and response arrangements will be re-examined against the local population distribution.

The population density and distribution criterion adopted for RR SMR deployment in Great Britain is that the site’s local population distribution shall be at or below the values given in the semi-urban criterion [33] as shown in Table 2.3-1.

Table 2.3-1: Semi-Urban Population Density and Distribution Criterion

Semi-Urban Value Number or Criterion	Site Population Factor Value or Criterion
Site Population Factor Value One	The cumulative weighted population values for any 30° sector in the ranges 0 – Ri (where Ri is a circle of radius i km and i varies from 2 to 30 km) shall not exceed those for a hypothetical 30° sector with a uniform population density of 5000 persons per km^2 from 1 to 30 km and zero population within 1 km.
Site Population Factor Value Two	The cumulative weighted population values all around the site in the ranges 0 – Ri (where Ri is a circle of radius i km and i varies in 1 km increments from 2 to 30 km) shall not exceed those for a hypothetical circle with a uniform population density of 1000 persons per km2 from 1 to 30 km with zero population within 1 km; where the weighting factors applied to the population within each radial band shall be proportional to 1/R$^{1.5}$ and R is the area-weighted average distance between the radial band and the site centre point.
Criterion	A site shall be determined to be potentially suitable for the deployment of new nuclear power stations if all the ratios of the actual versus the hypothetical cumulative weighted population values (‘Site Population Factors’) are less than unity, SPF(MAX) < 1

The treaties, laws, regulations, and guidance material that inform the design of the RR SMR to enable effective emergency preparedness and accident management have been collated in E3S Case Version 2, Tier 1, Chapter 19: Emergency Preparedness and Response [34]. This covers the provision of infrastructure, equipment, and outline development of on-site control room procedures. The provision of effective emergency preparedness and accident management processes are issues for planning authorities and operating licensees to address on a site-specific basis.

2.3.3 Connections to the Electrical Grid

Two offsite power connections are intended in the design, a primary connection for the import/export of power and an auxiliary connection for redundancy. The primary and secondary connections are single 400 kV connections and will interface with the generator transmission main connection [MS] and the station transformer [BCT] within the power transmission system [B]. The grid transmission system [A] and the generator transmission main connection [MS] are currently in development [35].

The output alternating current voltage and frequency of the RR SMR will comply with the UK specification standards, including 'The Grid Code' [36], such that it can be connected to the National Electricity Transmission System (NETS).

2.3.4 Loss of Off-Site Power

The National Grid continues to undergo significant changes through the installation of renewable energy sources and further modes of optimisation (for example, smart meters and upgrades to infrastructure). Climate change models also predict an increase in the frequency of challenging weather events, such as the storm that led to a loss of off-site power (LOOP) event at the Dungeness B nuclear power plant in 2013.

The LOOP frequency and duration assumptions for short/medium term and long-term outages are still being refined. At RD7/DRP1, the short/medium term outage has been defined as 72-hours and the long-term outage has been defined as 168 hours. The initiating event frequency of 5.5E-2/year has been assumed for the combined short/medium term value and 5.0E-5/year for the long-term outage [37].

The ability to import electrical power (for example, from the national grid) is dependent upon the functioning of the grid to provide power to the site's switch yard and the internal ability to transform and distribute the imported power. The reliability of the RR SMR's power system and the switch yard will be examined once the electrical equipment is designed later in the GDA process.

In relation to loss of off-site power (LOOP) faults, the frequencies of grid-related loss adopted for RR SMR are given in Table 2.3-2.

Table 2.3-2: Loss of Off-Site Power Criteria

Description	**Frequency (per year)**
72-hour hour loss of off-site power	5.5E-2
Long-term loss of off-site power (168 hours)	5.0E-5

2.3.5 Soil Properties

The National Policy Statement for Nuclear Power Generation (EN-6) ([31]and [32]) lists eight sites that are suitable for siting a 1 GW electrical output nuclear power plant (NPP). All proposed sites' lands are adjacent to previous NPPs and have been previously reviewed extensively and are therefore highly unlikely to give rise to geological features (for example, mines) which would make the area unsuitable for development. The sites do possess different soil conditions and four different ground conditions have been reviewed [38]. Four different geological classifications for the design basis of the load bearing ground underneath the plant in the concept design. These are:

- Stiff clay
- Dense sand
- Weak rock
- Strong rock.

These cover the range of geological and geotechnical conditions found at typical UK nuclear power station sites [38]. Organic soils, soft cohesive soils and loose granular soils are deemed unsuitable founding materials for the RR SMR raft structures as they are unlikely to provide adequate bearing capacity, settlement, or seismic performance [1].

The RR SMR project will follow the International Atomic Energy Agency (IAEA) safety guide for geotechnical aspects of site evaluation and foundations for nuclear power plants [39]. The IAEA safety guide outlines the recommended staged approach to ground investigations for siting, designing, and operating a nuclear power station.

2.4 Generic Site Description

2.4.1 Introduction

The GSD [40] for the RR SMR is the set of characteristics defining the range of sites that the RR SMR will be assessed against during GDA by the Environment Agency (EA) and Natural Resources Wales (NRW) [3]. It is part of the information requirements stipulated in EA Guidance on GDA for new nuclear power plants [3], and following review of recent EA guidance on site evaluation: generic developed principles [41].

The generic site characteristics provide the basis for indicative environmental assessments, including radiological dose assessments to humans and non-human biota, and initial assessment of the dispersion of gaseous and particulate emissions to air from on-site combustion sources and their impact on human health and ecological receptors.

These assessments are indicative only, and will be revisited at the site permitting stage, along with other environment assessments (for example, thermal and non-radiological impacts of cooling water plume dispersion modelling, impact of fish deterrent and return schemes) which may be required, using the site-specific characteristics of the selected site.

2.4.2 Overview of the Generic Site Description

Options for the development of the GSD were evaluated at Phase 1 of the Low Cost Nuclear Project, and recommendations for the characteristics of the generic sites were made [42].

The generic site is assumed to be coastal with the site being located approximately 100 m from the sea. The RR SMR will be cooled using mechanical draft cooling towers, with the cooling water demand being met by abstracted seawater. The following general assumptions have been made with regards to the generic site:

- The site and its surrounding area are assumed to lie on a flat plain with no large buildings in the immediate vicinity other than the RR SMR nuclear power plant
- The site is not located on an aquifer
- There is no standing water at the site
- No water bodies or watercourses cross the site
- There is no ground or groundwater contamination present on the site
- The site is located in a rural setting dominated by agricultural land use and fishing activity in the local seas
- There are no Protected Areas within the immediate vicinity of the site.

The GSD informs the selection of modelling parameters used in assessing potential environmental impacts associated with the RR SMR. Such parameters include:

- Meteorological and other parameters which affect gaseous dispersion and deposition

- Hydrographic and other parameters which affect aqueous dispersion
- Local exposure groups (for the purposes of dose assessment)
- Food consumption rates and other human habits data
- Reference organisms (for the assessment of radiological impacts on non-human biota)
- Availability of water for abstraction.

Details of the parameter values adopted for the assessment of radiological and conventional impacts for the RR SMR are presented in E3S Case Version 2, Tier 1, Chapter 30: Prospective Radiological Assessment at the Proposed Limits for Discharges and for any On-Site Incineration [43] and E3S Case Version 2, Tier 1, Chapter 31: Conventional Impact Assessment [44]. The RR SMR GSD parameters are selected to provide realistic but cautious criteria against which environmental impacts can be assessed and should reflect the categories of site which the RR SMR is likely to be deployed.

Consequently, it should be noted that, whilst the GSD and GSE share the same broad general characteristics, in order to satisfy the requirements of the three regulators [3], the GSD criteria may differ from the bounding values used to determine the GSE.

2.5 Conclusions

2.5.1 ALARP, BAT, Secure by Design, Safeguards by Design

The external hazard criteria have been defined in line with international standards, national standards, operational experience and relevant good practice. This is consistent with meeting the expectations of as low as reasonably practicable.

The location criteria are consistent with previous nuclear power plant sites in Great Britain which are well understood for their population distribution, emergency planning and response arrangements as well as meteorological, seismic and soil properties.

2.5.2 Assumptions and Commitments on Future Dutyholder / Licensee / Permit Holder

Assumptions and commitments raised on the future Dutyholder/Licensee/Permit Holder are summarised in Table 2.5-1.

Table 2.5-1: Assumptions and Commitments on Future Dutyholder/Licensee/Permit Holder

Assumption/Commitment	ID	Description
Commitment	C2.1	Carry out a rigorous comparison of any proposed site with the Generic Site Envelope criteria and determine if the site complies with the criteria laid down and resolve any gaps
Commitment	C2.2	Carry out screening and analyses of the suitability of any proposed site against any ‘out-of-scope’ external hazards and site-specific factors excluded from the Generic Site Envelope and determine if the site is acceptable
Commitment	C2.3	Develop further climate refinement models and employ adaptive management techniques to ensure that the operation of the plant remains safe beyond the year 2100

2.5.3 Conclusions and Forward Look

The generic E3S Case objective is ‘to provide confidence that the RR SMR design will be capable of delivering the E3S fundamental objective as it developed from a concept design into a detailed design’ [4]. This confidence is built through development and underpinning of top-level claims across each chapter of the E3S Case, through supporting arguments and evidence. The top-level claim for chapter 2 is ‘the RR SMR can be constructed, operated and decommissioned in suitable locations in Great Britain in a way that is safe, secure and that protects people and the environment’.

The arguments and evidence presented in Version 2 of E3S Case chapter 2 primarily include a set of bounding parameters for GSE defined to inform the design development and analysis of the RR SMR such that it enables deployment in suitable locations in GB. A summary of the GSD that has been developed to support environmental assessments is also presented.

Further arguments and evidence will be developed in line with the E3S Case Route Map [5] and reported in future revisions of the generic E3S Case, which will further build confidence that the RR SMR can deliver its fundamental E3S objective. This broadly includes further consideration of combinations of external hazards or combinations of internal and external hazards, refinement of LOOP frequencies, and any modifications to climate change projections or local population density and distribution criteria.

2.6 References

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2.7 Appendix A: Claims, Arguments, Evidence

Table 2.7-1 provides a mapping of the claims to the corresponding sections of the chapter that summarise the arguments and/or evidence. The full decomposition of claims and link to underpinning Tier 2 and Tier 3 information containing the detailed arguments and evidence is presented in the 'E3S Case Route Map' [5]. The route map includes the trajectory of Tier 2 and Tier 3 information as the generic E3S Case develops, which will be incorporated into Tier 1 chapters as it becomes available and in line with generic E3S Case issues described in [4].

Table 2.7-1: Mapping of Claims to Chapter Sections

Claim	**Section of Chapter 2 containing Arguments / Evidence summary**
All credible external hazards are identified and screened in a systematic manner using RGP	2.2.1, 2.2.2
Combined external hazards are identified and screened in a systematic manner using RGP	2.2.19
Design basis external hazard values are determined using codes and RGP	2.2.5 – 2.2.18, 2.3
The generic site envelope considers climate change for the expected life of the RR SMR	2.2.3
The generic site envelope provides a suitable basis for environmental assessment	2.4

2.8 Abbreviations

ACMS	Auxiliary Cooling and Make-Up System
ALARP	As Low As Reasonably Practicable
ASD	Atmospheric Steam Dump
BAT	Best Available Techniques
BS	British Standard
CCS	Component Cooling System
CME	Coronal Mass Ejection
DBE	Design Basis Earthquake
DRP1	Design Reference Point 1
E3S	Environment, Safety, Security and Safeguards
EA	Environment Agency
ECC	Emergency Core Cooling
ECCS	Emergency Core Cooling System
EMI	Electromagnetic Interference
EN	Euronorm
EN-6	National Policy Statement for Nuclear Power Generation, 2011
ESWS	Essential Service Water System
EUR	European Utility Requirements
GB	Great Britain
GDA	Generic Design Assessment
GIC	Geomagnetically Induced Current
GLE	Ground Level Enhancement
GMD	Geomagnetic Disturbance
GNSS	Global Navigation Satellite System
GSD	Generic Site Description
GSE	Generic Site Envelope
IAEA	International Atomic Energy Agency

IVR	In-Vessel Retention
LWR	Light Water Reactor
LOOP	Loss of Off-Site Power
LoS	Loss of Service
LUHS	Local Ultimate Heat Sink
MCWS	Main Cooling Water System
NETS	National Electricity Transmission System
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission
NRW	Natural Resources Wales, Cyfoeth Naturiol Cymru
OBE	Operating Basis Earthquake
ONR	Office for Nuclear Regulation
OPEX	Operational Experience
PC	Planning Condition
PDHR	Passive Decay Heat Removal
PGA	Peak Ground Acceleration
RCP	Representative Concentration Pathway
RD7	Reference Design 7
RFI	Radio-Frequency Interference
RGP	Relevant Good Practice
Ri	Circle of radius i kilometres
Rolls-Royce SMR Ltd	Rolls-Royce SMR Limited (the organization)
RSR	Radioactive Substances Regulation
RR SMR	Rolls-Royce Small Modular Reactor (the design)
SEP	Solar Energetic Particles
SMR	Small Modular Reactor
SRB	Solar Radio Burst

SSC	Structure, System and Component
TI	Turbine Island
UHS	Ultimate Heat Sink
UK	United Kingdom
UKCP18	UK Climate Projections 2018
US	United States of America