FIVE ESTUARIES OFFSHORE WIND FARM

ONSHORE SUBSTATION DESIGN PRINCIPLES DOCUMENT

Application Reference	EN010115
Application Document Number	9.4
Revision	A
APFP Regulation:	5(2)(q)
Date	March 2024

Project	Five Estuaries Offshore Wind Farm
Sub-Project or Package	Other Documents
Document Title	Onshore Substation Design Principles Document
Application Document Number	9.4
Revision	A
APFP Regulation	5(2)(q)
Eco-doc Reference	005023920-01

Revision	Date	Status/Reason for Issue	Originator	Checked	Approved
A	Mar 24	DCO Application	VEOWFL	VE OWFL	VE OWFL

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1. OVERVIEW

1.1. BACKGROUND

1.1.1. Five Estuaries Offshore Wind Farm Limited (the Applicant) has submitted an application to the Planning Inspectorate on behalf of the Secretary of State, for a Development Consent Order for the Five Estuaries Offshore Wind Farm (herein referred to as VE) under section 37 of the Planning Act 2008.

1.1.2. VE is the proposed extension to the operational Galloper Offshore Wind Farm. The project includes provision for the construction, operation, maintenance and decommissioning of an offshore wind farm located approximately 37 kilometres off the coast of Suffolk at its closest point in the southern North Sea; including up to 79 wind turbine generators and associated infrastructure making landfall at Sandy Point between Frinton-on-Sea and Holland-on-Sea, the installation of underground cables, and the construction of an electrical substation and associated infrastructure near to the existing Lawford Substation to the west of Little Bromley in order to connect the development to National Grid's proposed East Anglia Connection Node substation, which would be located nearby. All onshore connection infrastructure would be located in the administrative area of Tendring District Council, within Essex County Council. VE will have an overall capacity of greater than 100 Megawatts (MW) and therefore constitutes a Nationally Significant Infrastructure Project (NSIP) under the Section 15 (3) of the Planning Act 2008.

1.1.3. This Onshore Substation (OnSS) Design Principles Document combines the design principles and elements of a Design and Access Statement (DAS). It has been produced to be submitted as part of the DCO application, and provide a framework for design development for the OnSS.

1.1. DOCUMENT PURPOSE

1.1.1. At this stage in the VE development process, decisions on exact locations of infrastructure and the precise technologies and construction methods that will be employed have not been made. This includes the exact layout, equipment and technology of the OnSS.

1.1.2. In Section 2 Approach to Design the design principles that will be applied in the later detailed design are described alongside how the Applicant intends to manage the design process.

1.1.3. Section 3 The Site provides and overview of the key activities conducted in designing the project to date.

1.1.4. In Section 4 Onshore Substation Design and access Statement, The Maximum Design Scenarios (MDS) design parameters that the Applicant proposes to apply to the OnSS are outlined in the Design and Access Statement (DAS).

1.1.5. This document has been prepared in accordance with the design guidance contained in Overarching National Policy Statement (NPS) for Energy (NPS EN-1), the NPS for Renewable Energy Infrastructure (EN-3) and the NPS for Electricity Networks Infrastructure (EN-5).

2. APPROACH TO DESIGN

2.1. DESIGN PRINCIPLES

2.1.1. The National Infrastructure Commissions (NIC) Design Principles for National Infrastructure, 2020 will be applied for the VE project as shown in Table 1.

2.1.2. When considering the design choices the options will be measured against these principles.

Table 1 Application of the NIC Design Principles to the VE project

Principle	Aim	VE Objective
Climate	Help set the trajectory for the UK to achieve net zero greenhouse gas emissions by 2050 or sooner and be capable of adapting to climate change.	> Holistically minimise the environmental footprint of the development by making informed key design choices considering life cycle assessment principles, the circular economy and selection of material with low embodied carbon. > Contribute to the UK's renewable energy targets. > Design considering climate change.
People	Be at the human scale, instinctive to use and seek opportunities to improve the quality of life for people who live and work nearby.	> Collaborate with local communities and authorities to ensure the design choices are appropriate. > Strive for as unobtrusive a design as possible from, local viewpoints and residents, any public rights of way (PRoW) in the near vicinity > Minimise disruption to access to, and enjoyment of the area.
Places	Provide a sense of identity for communities, supporting the natural and built environment and enriching ecosystems.	> Blend into local agricultural setting with the existing and planned infrastructure in so far as is possible. > Deliver a net positive impact on the local ecosystems / biodiversity by actively seeking opportunities for rewilding, hedgerow planting, establishing wildlife corridors native tree planting.

Value	Provide value beyond the main purpose of infrastructure, solving problems well and achieving multiple benefits.	> Collaborate with adjacent projects to minimise disruption, re-use any necessary infrastructure and reduce impact of the collective developments where practicable.

2.2. DESIGN COLLABORATION

2.2.1. The project recognises that part of good design includes taking opportunities to collaborate with other nearby developments during the design, and construction phases in order to minimise impacts where possible and ensure an overall harmonious design. The Project has therefore sought, to find opportunities for design collaboration between, East Anglia Coastal Node substation (EACN) and the North Falls Offshore Wind Farm project ('North Falls' or 'NF') which are at a similar early stage in the design and engineering process.

2.2.2. This collaboration will be maintained as far as possible and has so far achieved alignment on offshore cable routing, onshore cable routing and construction access planning. Further detail on co-ordination between VE/NF is included in the Co-ordination Document (Document 9.30).

2.2.3. As the design progresses collaboration will continue. Examples of areas where collaboration in project design can seek to minimise the project's impact on the environment and local community are:

- Colour palettes and material selection for onshore infrastructure
- Layout of buildings and equipment within the site
- Planning of construction activities to minimise the temporary disruption
- Planning of ecological mitigation and planting

2.3. DESIGN REVIEW PROCESS

2.3.1. This section sets out the design review process that the Applicant will undertake post-consent. The review process will be overseen by the Project Design Champion with review at major design stage gates.

2.3.2. In order to secure the principles set out in Section 2, and recognising the functional and safety requirements of the substation design, the Applicant will create a 'Design Guide'. The Applicant will undertake consultation on the Design Guide to inform consultees of the emerging design, set out the rationale for key design choices and allow feedback to be provided to input to the developing substation design.

2.3.3. The Design Guide will set out the relevance of the principles for each design component and include discussion of how the proposed choices reflect these aims and objectives..

2.3.4. By setting out the rationale for the design choices that the Applicant intends to demonstrate how the emerging design choices are within the MDS, how the design principles have been applied, and also how the emerging design delivers mitigation measures from the EIA.

2.3.5. The guide will set out the aspects of the emerging design where further consultee input will be able to influence the design, and where there is limited or no optionality due to safety or functional requirements.

2.3.6. The Design Champion will lead the Design Review Panel which will be conducted in advance of consultation with statutory consultees and local residents. Consultation is likely to be in the form of written consultation with statutory consultees with local drop-in sessions for landowners and local residents. This will allow consultees and people living near to the substation to understand what is being proposed, and also provide feedback on design elements before further materials prepared and submitted to the relevant local planning authority to discharge the DCO requirement. The process of design review is shown in Figure 1.

2.3.7. Consultation on the Design Guide will include the opportunity for local community to meet with the Applicant in order to discuss and provide feedback upon the proposals for landscape planting within the Design Guide.

2.3.8. The Design Champion and Design Review Panel will include person(s) not directly involved in the design development and person(s) with the authority to influence the project within the Project Organization. They will be selected based on design experience, commitment to the design principles and seniority to hold the project team to account and challenge decisions when appropriate.

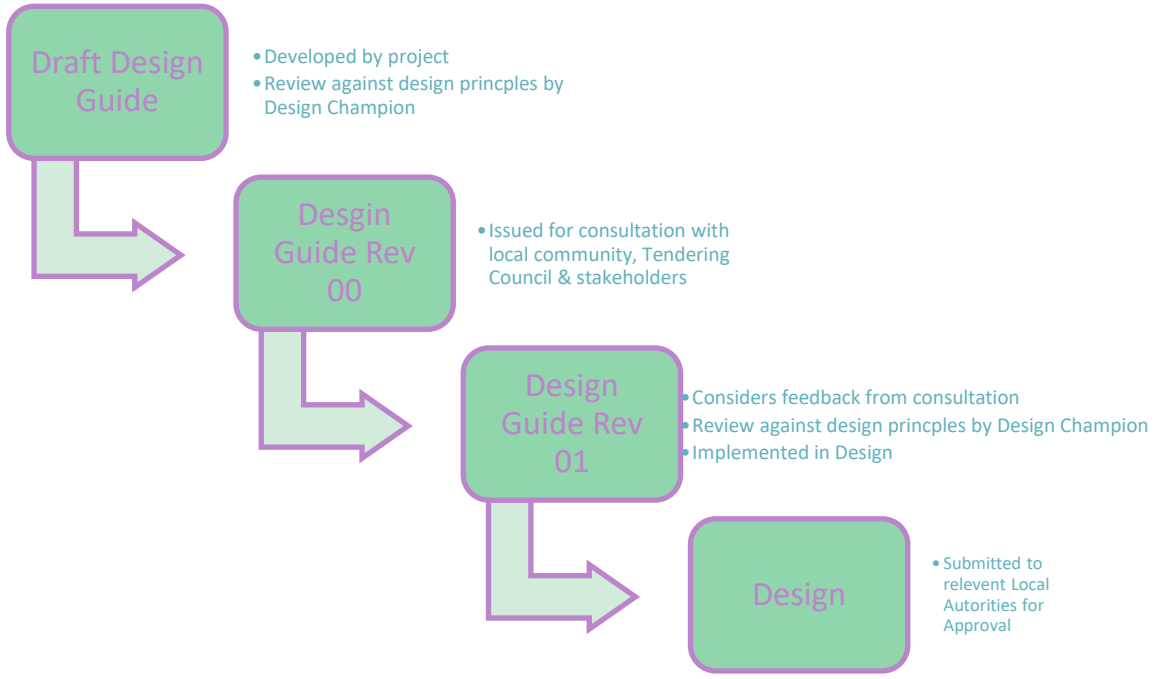


Figure 1 Design Review Process

2.4. DESIGN REFERENCES

2.4.1. There exists a significant number of relevant planning policy documents, national and local design guidance that will be considered when developing detailed design. These are summarized in Table 2.

Table 2 Applicable Design Guidance and Policy

Type	Title	Reference
National Planning Policy	National Policy Statement for Energy Infrastructure, 2023	NPS, 2023
	Overarching NPS for Energy, EN-1	NPS, 2023
	NPS for Renewable Energy Infrastructure, EN-3	NPS, 2023
	NPS for Electricity Networks Infrastructure, EN-5	NPS, 2023
National Design Guidance	National Infrastructure Commissions Design Principles for National Infrastructure	NIC, 2020
	IEMA Environmental Impact Assessment Guide to Developing Quality Development	IEMA, 2016+
	National Infrastructure Strategy	NIS, 2020
	National Grid Technical Specifications	NG TS
	Construction Design Management	CDM, 2015
	Building Regulations	2010 as updated 2022
Local Design Guidance	Tendring Landscape Character Assessment – LCA 7A	TLCA, 2001
	Essex Design Guide	EDG, 2018
	Essex Sustainable Drainage Systems Design Guide	ESuDS, 2020
	Essex Green Infrastructure Strategy	EGIS, 2020
	Essex Tree Palette	WTP, 2018

3. THE SITE

3.1.1. Appreciating the local environment of the onshore substation helps provide a better understanding of the existing landscape character, condition, visual amenity and underlying sensitivity of the area surrounding the onshore substation zone.

3.1.2. Gaining an understanding of the inherent opportunities and constraints within the site context and identifying particularly sensitive receptors to potential impacts has and continues to allow the project to develop more robust and locally appropriate solutions as part of the design response.

3.1.3. The site for the VE onshore substation is adjacent to the existing Lawford and planned National Grid substation and North Falls onshore substation. This DCO application relates solely to the VE substation, however consideration to and collaboration with the other projects is a key element of the design work.

3.2. SITE SELECTION

3.2.1. This section provides a simplified overview of the site selection process for the OnSS. It is intended to provide background information and is intended to help interested parties understand why the proposed OnSS site has been chosen as part of the design process.

3.2.2. A more detailed description of the site selection and consideration of alternatives can be found in Volume 6, Part 1, Chapter 4 Site Selection and Alternatives section of the Environmental Statement (ES).

3.2.3. The wider area for the location of the VE substation is determined by the grid connection offer “in the general area of Lawford substation and surrounds”. This defined the wider search area to locate a site.

3.2.4. To enable collaboration and minimize total environmental footprint associated with temporary and permanent construction there is a need for a co-located substation for VE and NF projects. This co-location provides the benefit of having a largely aligned export cable route that minimizes the temporary disturbance necessary for access, construction and operation. This approach also allows for the consideration of the sharing of substation access and haul roads.

3.2.5. Spatial planning consultants considered potential options for the co-located substations along the route to the grid connection offer area. Suitable zones were identified based on the following legislation, policy and best practice guidance;

- Environmental Impact Assessment Regulations;
- Habitats Regulations;
- The Electricity Act 1989;
- The Planning Act 2008;

- Overarching NPS for Energy (EN-1);
- NPS for Renewable Energy Infrastructure (EN-3);
- NPS Electricity Networks Infrastructure (EN-5);
- Planning Inspectorate Advice Note Nine: Rochdale Envelope;
- Planning Inspectorate Advice Note Seven: EIA;
- Overarching NPS for Energy (EN-1) (2011);
- EIA Guide to Shaping Quality Development (IEMA) (2015);
- The Horlock Rules.

3.2.6. Following the identification of the possible sites for the co-located substations, a more detailed assessment was conducted to classify the options in terms of environmental, consenting and engineering risk. This resulted in three shortlisted areas.

3.2.7. These shortlisted search areas were identified for further development and presented within the VE Non Statutory public consultation held between 30 June and 12 August 2022.

3.2.8. The selected search area was chosen primarily to give most opportunity for co-ordination with North Falls, noting that it also allowed a short and direct 400kV connection. The substation location within the selected search area was chosen based on option studies as it ensures there is sufficient room for the temporary construction compounds and planned substation size while also having the potential to facilitate mitigation planting and landscaping. Alternate options would require significant reduction in the substation or capacity or have the potential to be significantly impacted by proposed solar developments.

3.2.9. The selected area has been progressed to establish preferred preliminary layout / orientation of the substations within the area and determine the most appropriate access.

3.2.10. The preliminary layout was selected primarily as it is preferred from a visual perspective because it allows maximal coordination to achieve the most opportunity to coordinate visual impacts though alignment and reduce overall net impact, secondly it offers opportunity for a more optimum temporary construction compound (TCC) arrangement.

3.2.11. The project, however, requires the flexibility for modifications in detailed design that will adhere to the Design Principles as described in the Design Guide.

3.3. DESIGN WITHIN AND AROUND THE SITE

SITE CONTEXT

3.3.1. The site context is described within Volume 6, Part 3, Chapter 2: Landscape and Visual Impact Assessment (LVIA) chapter of the Environmental Statement. This will be considered in the Design Guide specifically addressing;

- Landscape Character designations at both local and national scale. These designations will inform the design by specifying the areas that may need to be specifically addressed;
- Local Colour sampling;
- Description of existing agricultural and commercial buildings and infrastructure;
- Public rights of way and visual receptors;
- Topography, the natural environment and ecology.

DESIGN FUNCTIONAL REQUIREMENTS

3.3.2. After establishing the site context, the design options and constraints such as functionally non- negotiable requirements will be described which includes but is not limited to switchgear; busbars; transformers; capacitors; reactors; STATic synchronous COMpensators (STATCOMs); harmonic filters; cooling equipment; control and welfare buildings; lightning protection rods (if required); internal road access and a security fence. The design parameters of these items are described in Section 4.

3.3.3. Layout of these substation components will be considered where technically and logistically possible to alleviate the impact and result in a design with lower overall impact.

OPTIONS AND PROPOSALS FOR DESIGN

3.3.4. The Design Guide will outline the various options and proposals and outline how these have been evaluated against the design principles.

3.3.5. In particular, the Design Guide will consider how mitigation planting helps to integrate the onshore project substation into the landscape and will explore the importance of colour in further enhancing this idea of integration. The options proposed will ensure that the onshore project substation is sensitive to place, with visual impacts minimised as far as practical by the use of appropriate design, planting and modifications to landscape topography and hydrology. The Design Guide will be developed in parallel with the operational drainage strategy, which will be in accordance with the principles of the Sustainable Drainage Systems (SuDS), as detailed in the Outline operational drainage layout, included at Annex B. A holistic approach will look to identify the best options which would integrate the drainage systems with the indigenous and proposed landscaping.

3.3.6. Due to the potential for differing development timelines of the VE, North Falls and National Grid substation projects, VE will seek preliminary collaboration on design choices to ensure alignment of aesthetic, and where possible layout options.

4. ONSHORE SUBSTATION DESIGN AND ACCESS STATEMENT

4.1. OVERVIEW

4.1.1. This section describes the key components of the proposed onshore substation, including details of the use, amount, scale, layout, landscaping and indicative appearance of the equipment. While final details are not yet known and will be influenced by discussions between VE and National Grid (NGET), the information included in this DAS is considered to be a reasonable worst case in terms of numbers and types of plant and equipment in the compound and their physical dimensions.

4.1.2. The outline electrical design for the substation has been completed to establish the equipment, however further optimization of the layout will be carried out following engagement with suppliers and as more information on the site ground conditions becomes available. The indicative layouts and elevations of the substation site for both AIS and GIS technology are included in Annex A.

4.1.3. The proposed OnSS is located to the east of the existing Lawford substation owned and operated by UK Power Network (UKPN). This proposed VE OnSS will eventually be owned and operated by an Offshore Transmission Owner (OFTO).

4.1.4. The proposed North Falls OWF project substation and National Grid's proposed East Anglia Connection Node (EACN) substation, both of which are currently in the pre-application planning phase, are proposed in the same local area. This has the potential to provide opportunities for co-ordination on items such as site access and mitigation planting. The need for co-ordination in design is discussed in section 2.2.

4.2. LAYOUT & EQUIPMENT

4.2.1. The OnSS will use comprise of either AIS or GIS design. The choice of switchgear affects both the total land area required and the size and type of buildings which will be needed. GIS substations are generally smaller in plan than their AIS counterparts, typically taking up an approximately 25 - 35% smaller footprint than an equivalent AIS substation, although they are likely to require a greater number of taller buildings. GIS substations typically require less maintenance as the interior elements are sealed and insulated. There are also potential environmental and ecological risks and benefits of either choice as well as visual preferences. The choice of AIS or GIS will be part of the detailed design process and a decision will be made post-consent prior to construction commencing.

4.2.2. The largest structure within the OnSS will be the OnSS building, with a maximum height of 15 m above the finished ground level of the OnSS (assuming a GIS design). All other equipment (e.g. transformers, switchgear) would be up to 12.5m above finished ground level with the exception of slender lightning masts which would be 18m in height. The land requirement for the OnSS to the perimeter fence is 58,800 m² (assuming AIS technology), as well as a 37,500 m² Temporary Construction Compound (TCC).

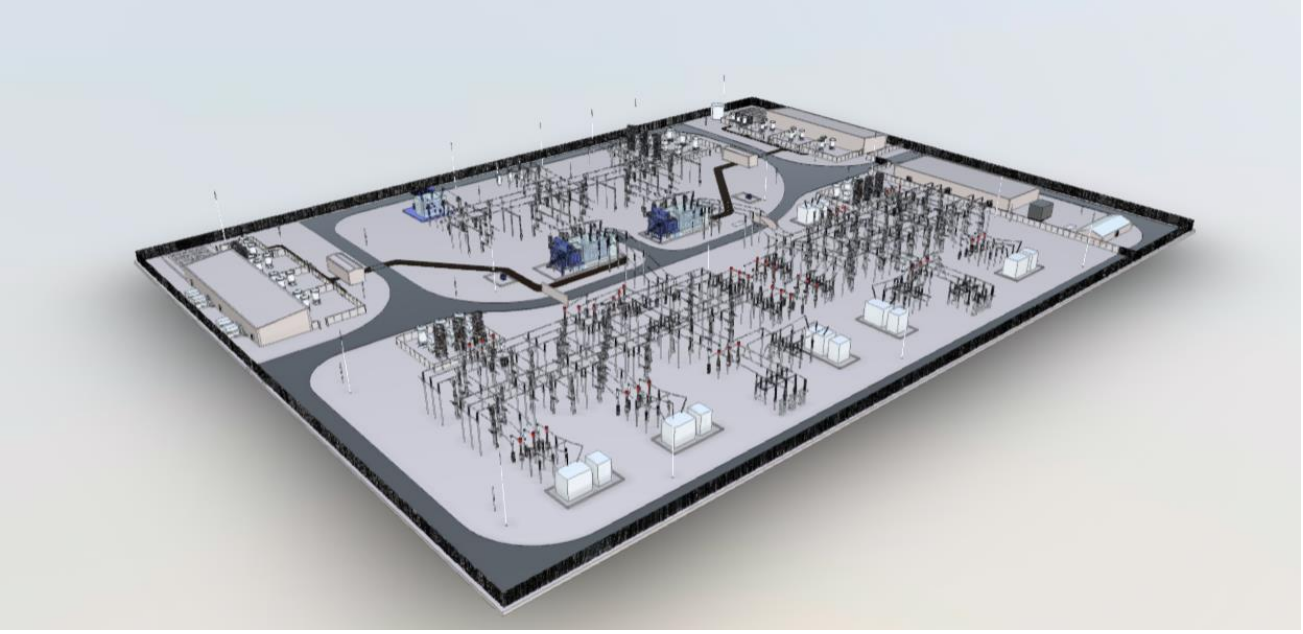


Figure 2 Indicative view of an AIS Substation

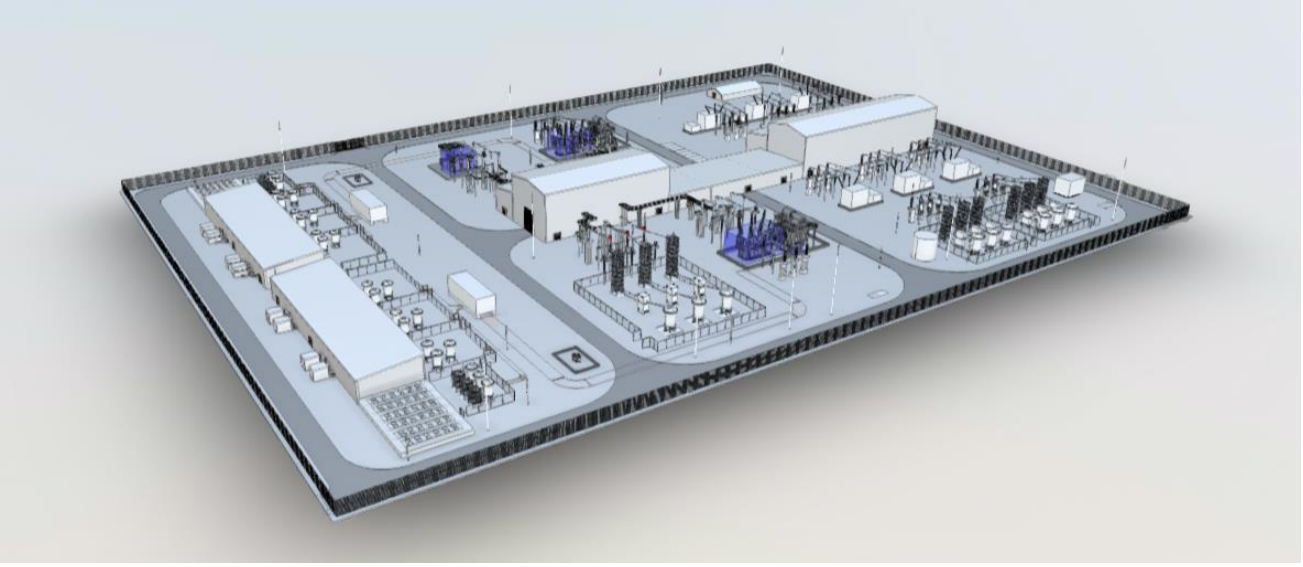


Figure 3 Indicative view of a GIS Substation

4.2.3. The environmental impact assessment (EIA) has assumed the maximum design scenario in assessing the onshore substation as part of the overall Project. The MDS for the AIS and GIS options is shown below for ease.

Substation	Max Design Scenario
Indicative dimensions of AIS site	280 m x 210 m
Max area of AIS site	58,800 m²
Indicative dimensions of GIS site	250 m x 180 m
Max area of GIS site	45,000 m²
Indicative number of buildings	6
Indicative building dimensions	1 x 400 kV GIS building: 40 x 28 x 15 m high (only required for GIS substation, not for AIS) 1 x 275 kV GIS building: 60 x 27 x 15 m high (only required for GIS substation, not for AIS) 2 x STATCOM (Control & Valve) buildings: 55 x 15 x 7 m 1 x Control building (possibly several adjacent containerised buildings): 50 x 20 x 5 m 1 x Storage/Amenity building: 20 x 9 x 4 m
Max external equipment height	15 m
Max area of TCC	37,500 m²

4.3. USE

4.3.1. The proposed OnSS is a key component of the Project and will be required to convert electricity generated at the offshore wind farm to a higher voltage suitable for onward transmission to NGET's electricity transmission system.

4.3.2. The high voltage cables between the VE and NGET substations will be underground and no overhead transmission lines are proposed as part of VE.

4.3.3. The OnSS will be designed to be unmanned during operation. To accord with NGET's standards the site is likely to require a 3.4m high security perimeter fence. CCTV will give remote observation capability 24 hours a day, thus the development will not require day to day access and will not be open to the public. The choice of materials and colour of any fencing will be subject to the Design Guide and design principles.

4.4. LAYOUT

4.4.1. The proposed onshore substation will be located in the vicinity of the existing Lawford 132kV substation. The boundaries of the onshore substation site are defined by:

- An 132kV overhead line running west to east through the north of the site which is connected in to the existing Lawford substation with two 132kV towers sited just outside the substation site.
- Ardleigh Road and Grange Road which border the substation site to the south, west and north.
- To the east the site is bordered by an existing drainage ditch which would need to be slightly re-aligned and the proposed North Falls substation would border the OnSS to the east if built.

4.4.2. For the purpose of undertaking the EIA, a worst-case layout for AIS and GIS technologies created by combining the maximum footprint with the maximum height have been used in Volume 6, Part 3, Chapter 2: Landscape and Visual Impact Assessment (LVIA) of the Environmental Statement (ES).

4.4.3. Within the proposed layout a number of further options may be possible within the OnSS Footprint. The final configuration will be determined during the detailed design stage and will depend on the ultimate electrical system design including the number and rating of cables, the choice of electrical contractor, the manufacturer of the equipment and other engineering factors. As described in Section 4.2 the OnSS design envelope allows for either an AIS or GIS layout depending on the ultimate electrical system design. These components are set out below. Further optimization of the layout will be carried out as more information on the site ground conditions becomes available and detailed design is undertaken. The key principles that have been employed to derive the indicative layout (and will be employed during future layout refinement) are identified as follows:

- The design, layout and installation of all plant and equipment within the substation will allow operation and maintenance in accordance with all relevant statutory requirements (e.g. the Health and Safety at Work etc Act 1974).
- Existing trees and hedgerows will, where possible, be retained to provide screening during construction and operation of the OnSS. Additional mitigation planting is proposed within the site.
- Due to the existing 132kV overhead line infrastructure, no operational equipment will be installed beneath this equipment. Fence lines running parallel with and equipment adjacent to the overhead lines will observe the minimum clearances to exposed overhead conductors as set out in the relevant substation design standards (approximately 5 metres).
- As a requirement, based on National Grid technical standards, equipment within the substation will be located a minimum of 3 metres from the fence line for security and safety reasons.
- Heavy equipment (e.g. the main transformer, described below) will be located adjacent to the main internal site access road for ease of installation.
- Fire Damage Zones (FDZ) for equipment containing oil will be considered when producing the layout to ensure there is adequate spacing between substation components. All equipment located within the substation compound will be positioned to comply with the appropriate horizontal and vertical design clearances for the relevant voltage level.
- Equipment containing oil will have a bund type foundation with sufficient internal clearance at ground level between the equipment and the bund wall.
- The layout will look to optimise the use of space in order to minimise the overall substation footprint. This also allows for all construction areas to be accommodated within the wider substation area.
- The site topography is such that a degree of cut and fill will be required to provide a level platform upon which to construct the OnSS. The cut and fill balance on the substation site will look to establish a substation platform level at approximately 35.8m AOD which is within 1.0m of the current 35m AOD.
- The layout will consider and seek to minimize the impact of noise on nearby receptors.

4.5. AMOUNT AND SCALE OF NECESSARY EQUIPMENT

4.5.1. The proposed onshore substation will contain a range of electrical equipment, including transformers, reactive compensation equipment and control buildings (likely to be two stories high), segregated from the High Voltage (HV) equipment all located within the substation boundary fence (the compound). It is anticipated that the substation will take between 18 and 27 months to build.

4.5.2. The majority of the equipment is not expected to be taller than 10 m (and in most cases much lower) – however, some of the equipment will extend up to 15 m at its highest points.

4.5.3. The maximum height of equipment and buildings is defined within the design parameters of the draft DCO. This is described in the Landscape and Visual Impact (LVIA) (Volume 6, Part 3, Chapter 2), and within the Onshore Project Description (PD) (Volume 6, Part 3, Chapter 1) of the Environmental Statement (ES)

4.5.4. The VE DCO application will include works for the cable connection between the new VE OnSS to the National Grid substation and may include some works to facilitate the connection within the National Grid substation such as:

- Installation of switchgear bays in the National Grid EACN substation;
- Installation of troughs / ducts to facilitate the 400kV circuits, Protection & Control cables from the VE onshore substation into the switchgear bays.
- Installation and termination of the 400kV circuits and Protection & Control cables between the VE substation and the switchgear in the National Grid EACN substation;
- Installation of protection and control equipment (if required) within the National Grid relay building; and
- Temporary infrastructure such as haul roads and construction compounds to facilitate access, egress, laydown, storage and welfare containers which would be placed within close proximity of the work area.

4.5.5. The current design has allowed for a number of buildings:

- 1 x 400 kV GIS building: 40 x 28 x 15 m high (only required for GIS substation, not for AIS)
- 1 x 275 kV GIS building: 60 x 27 x 15 m high (only required for GIS substation, not for AIS)
- 2 x STATCOM (Control & Valve) buildings: 55 x 15 x 7 m
- 1 x Control building (possibly several adjacent containerised buildings): 50 x 20 x 5 m
- 1 x Storage/Amenity building: 20 x 9 x 4 m

4.5.6. The GIS option for the OnSS requires switchgear equipment to be housed within a building. This GIS switchgear building will be the tallest component of either layout (excluding lightning conductors). Other buildings for control functions, welfare and other uses will be required although these will have a smaller footprint and lower height than the GIS switchgear building. The GIS layout potentially has a less pronounced horizontal profile than the AIS layout as it has more variation in the height of its visible components.

4.5.7. The AIS option for the OnSS does not require a switchgear building as the switchgear is left open to the air. Other buildings for control functions, welfare and other uses will be required. The AIS development has a more industrial appearance due to its wider horizontal profile and has a larger footprint than the GIS option.

4.5.8. Set out below are more detailed descriptions of the likely appearance and approximate size of some of the key larger equipment to be installed at the proposed substation.

TRANSFORMERS

4.5.9. The transformers step up the offshore wind farm transmission voltage to the 400kV required to export the offshore wind farm. The indicative size of each of the units is 6m by 16m by 12.5 high (to the top of the bushings). Transformers are typically painted grey.

REACTIVE COMPENSATION EQUIPMENT

4.5.10. Reactive compensation equipment is used to condition the wind farm power prior to export to the transmission system, to ensure it complies with the requirements set out by the transmission system operator. Typically, one set of reactive compensation equipment is required for each circuit connecting to the transmission system.

4.5.11. Reactive compensation equipment will typically consist of a STATCOMS unit and separate sets of reactors. The indicative size of the reactive compensation control unit is 4m by 7.5m by 7.1m high. The level of reactive power required from the reactors (and therefore their size) cannot be determined at this early stage, but all equipment will fit within the maximum dimensions set out in the MDS described in Volume 6, Part 3, Chapter 1: Onshore Project Description (PD) and Volume 6, Part 3, Chapter 2: Landscape and Visual Impact (LVIA) sections of the Environmental Statement (ES).

HARMONIC FILTERS

4.5.12. Harmonic filters are used at the substation to ensure that the power exported to the grid complies with the quality of supply requirements set out by the transmission system operator. Typically, one set of harmonic filtering is required for each export circuit and a 400kV harmonic filter might be required for the circuit connecting to the transmission system. For the illustrative layout at Annex A it has been assumed that each harmonic filter compound will be of dimensions approximately 22.5 m by 20m with an expected height of the filters to be from 10 m to 12.5m.

CIRCUIT BREAKERS AND BUSBARS

4.5.13. The electrical busbars are used to connect the various pieces of electrical equipment within the substation together. Circuit breakers are placed at strategic points within the busbar system in order to allow sections of the wind farm electrical network to be switched out with minimum disruption to the wind farm operation.

4.5.14. The circuit breakers and busbars used for the illustrative substation layout at Annex A have been based upon air insulated equipment.

AUXILIARY TRANSFORMERS

4.5.15. In addition to the main transformers the substation will also have a set of smaller auxiliary transformers to provide a low voltage supply to the substation control buildings and auxiliary systems.

CONTROL BUILDINGS AND ANCILLARY STRUCTURES

4.5.16. In addition to the main control buildings, smaller switchroom buildings will be located within the substation compound adjacent to its associated equipment.

4.5.17. An underground septic tank would be included on site with dimensions in the order of approximately 6m by 3m.

4.5.18. A water deluge tank has been included within the compound for the purpose of storing water for use in the event of a substation fire. This would have indicative dimensions of 6.5m wide by 6.0m high.

4.5.19. Development of the OnSS will result in the construction of low permeability surfacing, increasing the rate of surface water runoff from the site. A surface water drainage scheme is proposed to ensure the existing runoff rates to the surrounding water environment are maintained at pre-development rates.

4.5.20. The drainage design will consist of swales and / or attenuation ponds. Filter drains will collect runoff from the internal access roads within the substation site and convey runoff to swales and / or attenuation ponds. Outfall locations are proposed to the unnamed ordinary watercourse located south of Ardleigh Road and to the unnamed drainage ditch north of Ardleigh Road. An outline operational drainage layout is included at Annex B.

4.5.21. The detailed design (post-consent) of the surface water drainage scheme will be based on a series of infiltration/soakaway tests carried out on site and the attenuation volumes outlined in the supporting OnSS FRA Volume 5, Report 3.2: Onshore Substation Flood Risk Assessment. The tests will be undertaken prior to construction and in accordance with the BRE Digest 365 Guidelines in order to determine the suitability of ground for accepting a drainage discharge.

4.6. APPEARANCE

4.6.1. The appearance of the overall substation structure primarily derives from its functional need and the safety requirements of this development. The substation will step-up and transfer the electricity from the VE OWF. Therefore, the design of the substation is appropriate to that use. The most appropriate final colour of the substation will be assessed within the Design Guide, and be considered against the existing Lawford substation; that is grey; and where possible alongside the proposed EACN and North Falls substations depending on the development timelines for the projects.

4.6.2. By using an industrial style design for the structures and including security style fencing it will be clear that this is not a public facility. The indicative site elevations and the structures that exceed the height of the fencing are required for the operation of the substation, and again derive from the functional needs of the site. Indicative elevations to give an impression of the industrial style design of the structures are shown at Annex A.

4.6.3. A visible feature of the site will be the security fencing along the external boundary. This will be addressed within the design guide and where possible considered alongside the proposed EACN and North Falls substations depending on the development timelines for the projects.

4.6.4. The substation will require permanent CCTV equipment and external fencing, to a specified security standard for this type of installation, to safeguard personnel and prevent unauthorized access. Signage in accordance with the Electricity Supply Regulations will be located in conspicuous positions along this perimeter fence.

4.6.5. Permanent light fittings will be installed around and within the substation. Under normal operating conditions the substation will not be illuminated at night. Lighting will be used only when required for maintenance outages or emergency repairs occurring at night. The lights will be directed downward, and shielded to reduce glare outside the facility.

4.6.6. Task-specific lighting will be needed externally, however, this will only be required on a very infrequent basis. If lighting is required along the access track from Ardleigh Road to the substation, this would be low level, bollard lighting that would only be used when visits to the site are made.

4.7. LANDSCAPING & ECOLOGICAL MITIGATION

4.7.1. The final form of the substation structures will be integrated into the surrounding environment through the adoption of a robust, sustainable landscape planting and ecological mitigation strategy as outlined in the Landscape and Visual Assessment of the ES (Volume 6, Part 3, Chapter 2) and the Onshore Biodiversity & Nature Conservation chapter of the ES (Volume 6, Part 3, Chapter 4).

4.7.2. In between the structures on site, permeable areas will be topped with locally sourced stone chippings to promote natural drainage. Where possible, chippings will be recycled from other applications (such as railway ballast) and/or sourced locally.

4.7.3. Prior to construction, VE will be required to submit a written landscaping and ecological mitigation scheme and associated work program (in accordance with the principles set out in the Volume 9 Report 22 Outline Landscape and Ecological Management Plan (Outline LEMP), to relevant local planning authority for approval.

4.8. LOW IMPACT DESIGN

4.8.1. Approaches to minimize the carbon footprint of the buildings will be evaluated such as the use of solar panels, layout to benefit from solar gain & shading, rainwater harvesting, selection of materials. These choices will be evaluated on a Life Cycle Assessment (LCA) basis to understand the overall impact they will have.

4.8.2. These choices will be balanced with the competing impacts to ensure balanced decision making process.

4.9. ACCESS

VEHICULAR AND TRANSPORT LINKS

4.9.1. The access options for the OnSS that have been evaluated are discussed in detail in Volume 6, Part 1, Chapter 4: Site Selection and Alternatives of the ES. An overview of the process is provided here.

4.9.2. A series of initial assessments were made by the VE project, North Falls and NGET projects that identified a set of options considering abnormal load requirements, use of the existing road network, use of private roads and environmental and cultural constraints.

4.9.3. These 6 options were jointly assessed by VE and North Falls projects with VE's specialist environmental consultant considering the route lengths, amount of improvement works required, number of roads and fields impacts, number and proximity of residential properties, civic buildings (including schools) rail crossings, and trees, hedgerows and ecological receptors.

4.9.4. This assessment resulted in a short list of viable options with preferred options for construction and operation. These options were taken thought to a subsequent coordinated evaluation exercise between VE, North Falls and NGET.

4.9.5. The selected route includes permanent road improvements to the A120/Bentley Road junction and widening to the Bentley Road highway, along with a new temporary haul road running within the ECC for substation construction traffic from Bentley Road to Ardleigh Road.

ACCESS DURING OPERATION

4.9.6. The substation site will not be open to members of the public and will not have permanent staff on the site. However, for the purposes of all staff required to go to the site for operational and maintenance reasons, the relevant legislation and guidance has been considered in relation to access for all. The Equality Act 2010 will be taken into account. Buildings will be designed and constructed to ensure that the needs of people with disabilities are accommodated to allow for access to suitable car parking, facilities, washing and toilet facilities.

4.9.7. It is expected that during operation workers will require vehicular access to enable tools and equipment to be taken to site. The site will however be secure, meaning that should workers be able to travel via bicycle this option will be available as secure areas for bicycle storage would be available.

4.9.8. As the substation is unmanned during operation and workers will only intermittently access the site a public transport plan is not considered necessary.

PEDESTRIANS AND CYCLISTS

4.9.9. During construction the construction traffic will be subject to a Construction Traffic Management Plan (and Outline CTMP is provided as part of the application (Volume 9 Document 24)) which would seek to minimise the impact of construction on pedestrians and cyclists users. The requirement for a Construction Traffic Management Plan to be produced is secured in the draft DCO.

4.9.10. The impact on pedestrians and cyclists is assessed and management is described in an outline Public Access Management Plan has been provided in Volume 9 Document 25 of the Application.

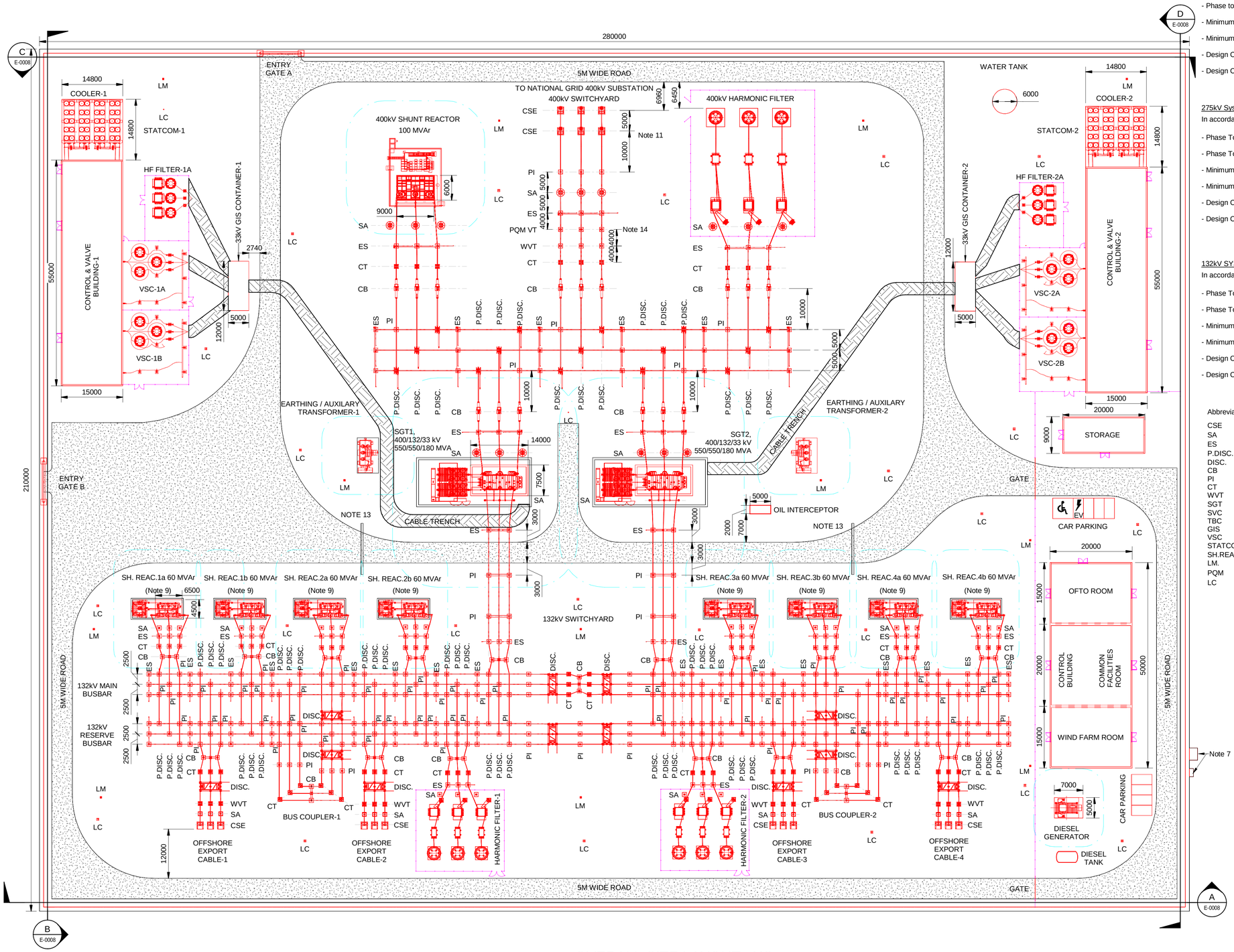
4.9.11. Due to the unmanned nature of the substation it is not expected that during operation of the substation any additional traffic caused by the proposed substation will significantly affect the levels of amenity for cyclists and pedestrians using surrounding roads.

4.9.12. Public rights of way were considered during the Site Selection, in order to minimise the impact. This is outlined in the Section 3.2 and supporting documents.

PUBLIC TRANSPORT DURING CONSTRUCTION

4.9.13. During construction, a Workforce Travel Plan will be in place to secure measures to reduce vehicle numbers accessing the site. An outline Workforce Travel Plan is provided as part of the application (Volume 9, Document 26). This provides a framework for promoting and encouraging a reduction in private cars during construction for the OnSS.

ANNEX A: OUTLINE SUBSTATION LAYOUTS AND ELEVATIONS



OVERALL SITE LAYOUT -AIS

1 : 500

Table of Clearances

400kV System

In accordance with NG TS 2.1

- Phase to Earth (PE)	2.8m
- Phase to Phase (PP)	3.6m
- Minimum Insulation Height	2.4m
- Minimum Safety Distance (SD)	3.1m
- Design Clearance of Safety (Horizontal)HSC	4.6m
- Design Clearance of Safety (Vertical) VSC	5.5m

275kV System

In accordance with NG TS 2.1

- Phase To Earth (PE)	2.1m
- Phase To Phase (PP)	2.4m
- Minimum Insulation Height*	2.4m
- Minimum Safety Distance (SD)*	2.4m
- Design Clearance of Safety (Horizontal) HSC	3.9m
- Design Clearance of Safety (Vertical) VSC	4.8m

132kV SYSTEM

In accordance with NG TS 2.1

- Phase To Earth (PE)	1.1m
- Phase To Phase (PP)	1.4m
- Minimum Insulation Height*	2.4m
- Minimum Safety Distance (SD)*	1.4m
- Design Clearance of Safety (Horizontal) HSC	2.9m
- Design Clearnace of Safety (Vertical) VSC	3.8m

Abbreviations:

CSE	-Cable Sealing End
SA	-Surge Arrestors
ES	-Earth Switch
P.DISC.	-Pantograph Type Disconnector
DISC.	-Rotating Type Disconnector
CB	-Circuit Breaker
PI	-Post Insulator
CT	-Current Transformer
WVT	-Wound Voltage Transformer
SGT	-Super Grid Transformer
SVC	-Static VAR Compensator
TBC	-To Be Confirmed
GIS	-Gas Insulator Switchgear
VSC	-Voltage Source Converter
STATCOM	-Static Synchronous Compensator
SH.REAC.	-Shunt Reactor
LM.	-Lightning Mast
PQM	-Power Quality Monitoring
LC	-Lighting Column

Notes

1. Dimension is in mm unless stated otherwise.
2. This layout is indicative only. The following aspects shall be considered when developing the design:
   - Magnetic clearance from the air core reactors
   - Fire Suppression Systems
   - Site Lighting and Security Systems
   - Pedestrain Access requirement to equipment / building.
   - Lightning Protection
3. The equipment appearance and size shown are indicative only.
4. Reactive compensation equipment and Harmonic Filters are indicative only.
5. Water supplies for the fire fighting purposes to be made available for the use by the Fire Bridge (Hydrant to be provided within 90m of all the equipment and buildings)
6. The following fencing requirements have been assumed:
   Internal Fence: 2.4M High non-electric fence
   Perimeter Fence: 3.4M High Physical Mesh / Palisade Barrier with Electric Pulse Fence.
7. DNO cabinet and substation are indicative only. Location shall be agreed and confirmed by the distributor.
   Indicative heights of the building and main equipment:
   - Power transformer noise enclosure : 7M
   - STATCOM building: 7M
   - Harmonic Filter: 12.5M
   - Storage building: 4M
   - Control building: 5M
   - Shunt Reactor noise enclosure: 7M
   - Water Tank: 6M
   - Diesel Generator: 5M
8. Overall substation compound footprint is 5.88 hectares (58,800 sqm)
9. Ratings of equipment for reactive compensation is indicative and based on the allowed footprint.Actual equipment rating required shall be confirmed by system studies.
10. Shunts Reactors may be banked with export circuits depending on the final arrangement.
11. Abnormal busbar length (removable section) between CSE and PI towards NGET substation to provide Point of Isolation
12. Noise enclosure on transformers and shunt reactors is fitted around transformer tank only
13. Denotes 3m height barrier to be provided
14. Additional PQM VT added as per client request.Requirement shall be confirmed at later design stage.
15. Access Gate A shall be provided in case of S27 zone, Gate B shall be provided in case of S99 zone.
16. Lighting column type, number and location is indicative and shall be confirmed by lighting study.

Key to symbols

- Indicative Fire Damage Zone
- Indicative Internal Fence
- Indicative External Fence
- Indicative 18m Lightning Mast Location
- Lighting Column - 6m (Note 16)

Reference drawings

004369952	Five Estuaries Wind Farm Onshore Substation Single Line Diagram - AIS
004369956	Five Estuaries Wind Farm Onshore Substation Elevations - AIS

Rev	Date	Drawn	Description	Ch'k'd	App'd
05	30.09.22	SK	Updated as per Client comments	GR	PL
04	09.09.22	SK	Revised as per Client comments	GR	PL
03	09.08.22	SK	Section lines added	GR	PL
02	14.07.22	SK	Revised as per the comments	GR	PL
01	23.06.22	SK	Issued for Review	GR	PL

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Client

FIVE ESTUARIES OFFSHORE WIND FARM

Title

FIVE ESTUARIES WIND FARM ONSHORE SUBSTATION OVERALL SITE LAYOUT - AIS

Sheet 01of 01

Designed	S Banerjee	SB	Eng. Check	G Rossi	GR
Drawn	S Kale	SK	Coordination	L Thomas	LT
Dwg. Check	G Rossi	GR	Approved	P Lear	PL

MMD Project Number 104560	Scale at A1 1:500	Security STD
Client Number 004369954		Suit. Code S3
Drawing Number 104560-MMD-00-XX-DR-E-0006		Rev 05

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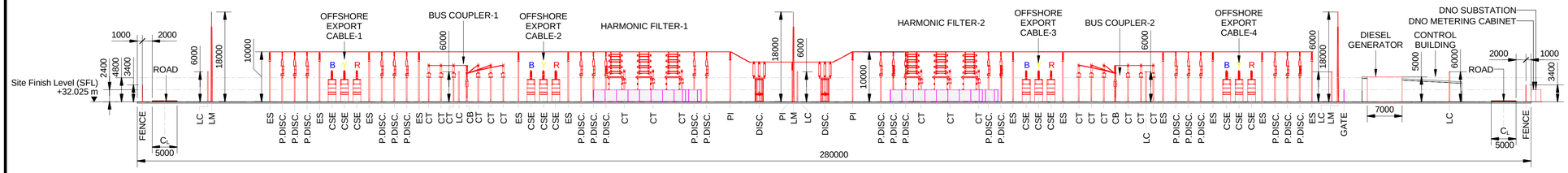

ELEVATION A
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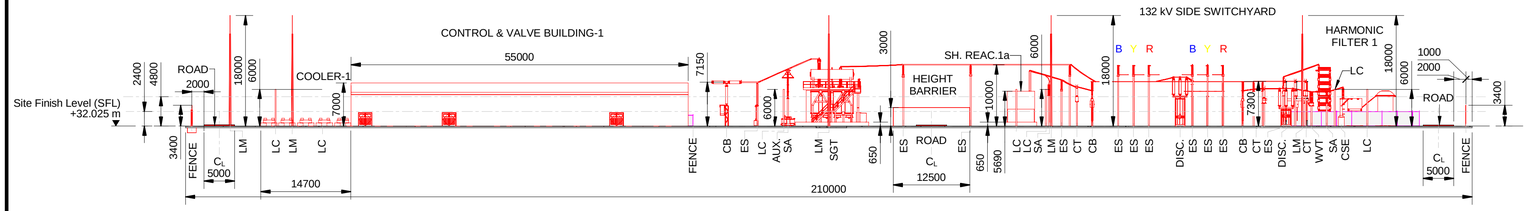

ELEVATION B
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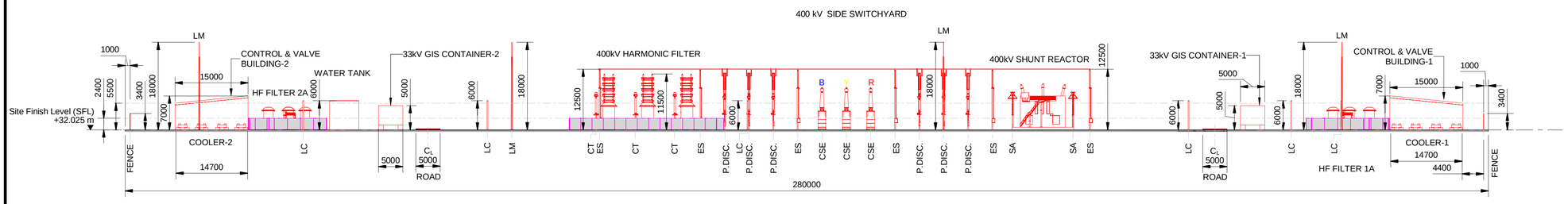

ELEVATION C
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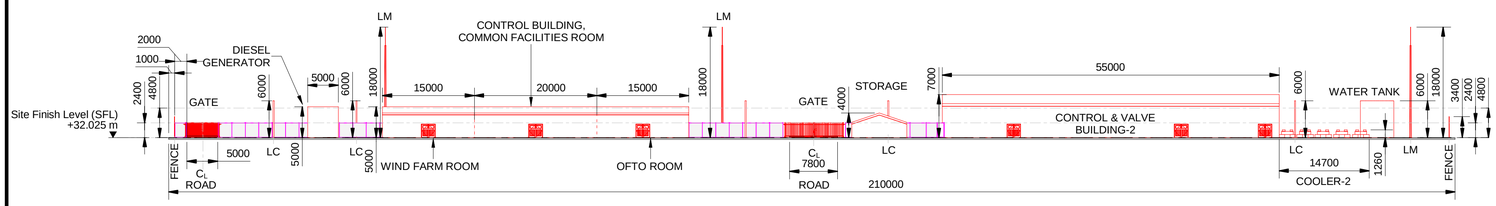

ELEVATION D
1 : 500 — E-0006

Table of Clearances

400kV System

In accordance with NG TS 2.1

- Phase to Earth (PE)	2.8m
- Phase to Phase (PP)	3.6m
- Minimum Insulation Height	2.4m
- Minimum Safety Distance (SD)	3.1m
- Design Clearance of Safety (Horizontal)HSC	4.6m
- Design Clearance of Safety (Vertical) VSC	5.5m

275kV System

In accordance with NG TS 2.1

- Phase To Earth (PE)	2.1m
- Phase To Phase (PP)	2.4m
- Minimum Insulation Height*	2.4m
- Minimum Safety Distance (SD)*	2.4m
- Design Clearance of Safety (Horizontal) HSC	3.9m
- Design Clearance of Safety (Vertical) VSC	4.8m

132kV SYSTEM

In accordance with NG TS 2.1

- Phase To Earth (PE)	1.1m
- Phase To Phase (PP)	1.4m
- Minimum Insulation Height*	2.4m
- Minimum Safety Distance (SD)*	1.4m
- Design Clearance of Safety (Horizontal) HSC	2.9m
- Design Clearnace of Safety (Vertical) VSC	3.8m

Abbreviations:

CSE	-Cable Sealing End
SA	-Surge Arrestors
ES	-Earth Switch
P.DISC.	-Pantograph Type Disconnector
DISC.	-Rotating Type Disconnector
CB	-Circuit Breaker
PI	-Post Insulator
CT	-Current Transformer
WVT	-Wound Voltage Transformer
SGT	-Super Grid Transformer
SVC	-Static VAR Compensator
TBC	-To Be Confirmed
GIS	-Gas Insulator Switchgear
VSC	-Voltage Source Converter
STATCOM	-Static Synchronous Compensator
SH.REAC.	-Shunt Reactor
LM.	-Lightning Mast
PQM	-Power Quality Monitoring
LC	-Lighting Column

0 — 25m — 50m
1:500

Notes

1. Dimension is in mm unless stated otherwise.
2. This layout is indicative only. The following aspects shall be considered when developing the design:
   - Magnetic clearance from the air core reactors
   - Fire Suppression Systems
   - Site Lighting and Security Systems
   - Pedestrain Access requirement to equipment / building.
   - Lightning Protection
3. The equipment appearance and size shown are indicative only.
4. Reactive compensation equipment and Harmonic Filters are indicative only.
5. Water supplies for the fire fighting purposes to be made available for the use by the Fire Bridge (Hydrant to be provided within 90m of all the equipment and buildings)
6. The following fencing requirements have been assumed:

   Internal Fence: 2.4M High non-electric fence
   Perimeter Fence: 3.4M High Physical Mesh / Palisade Barrier with Electric Pulse Fence.
7. DNO cabinet and substation are indicative only. Location shall be agreed and confirmed by the distributor.
   Indicative heights of the building and main equipment:

   - Power transformer noise enclosure : 7M
   - STATCOM building: 7M
   - 400kV Harmonic Filter: 12.5M
   - 132kV Harmonic Filter: 10M
   - Storage building: 4M
   - Control building: 5M
   - Shunt Reactor noise enclosure: 7M
   - Water Tank: 6M
   - Diesel Generator: 5M
8. Design for export voltage switchgear has been developed considering 132kV horizontal and 275kV vertical clearances as to allow both voltage levels to be selected at later stage.

Key to symbols

Reference drawings

004369952	Single Line Diagram -AIS
004369954	Overall Site Layout -AIS

Rev	Date	Drawn	Description	Ch'k'd	App'd
03	30.09.22	SK	Updated as per Client comments	GR	PL
02	09.09.22	SK	Revised as per Client comments	GR	PL
01	09.08.22	SK	Issued for Review	GR	PL

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Client

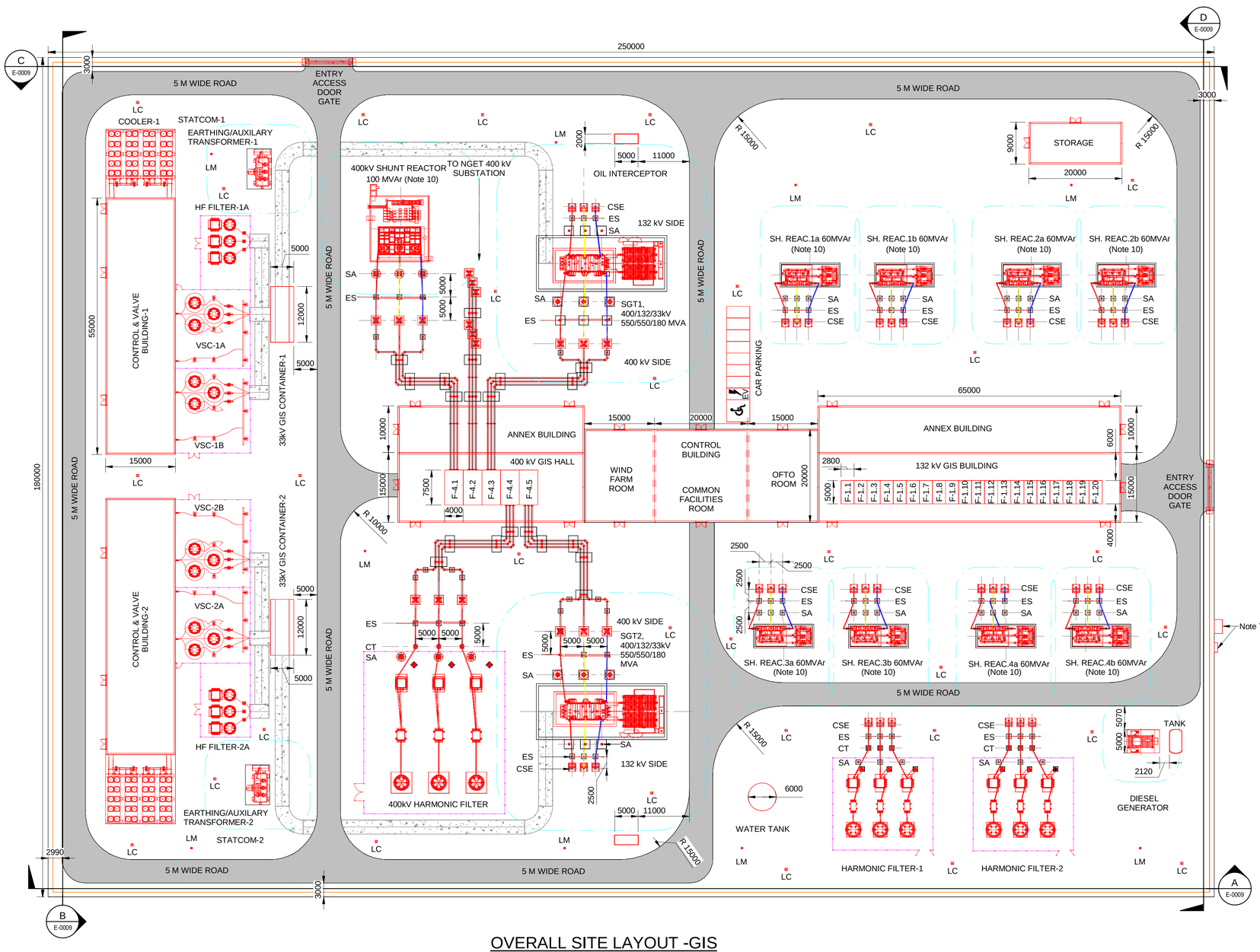
FIVE ESTUARIES OFFSHORE WIND FARM

Title

FIVE ESTUARIES WIND FARM ONSHORE SUBSTATION ELEVATIONS OF SUBSTATION COMPOUND- AIS OPTION Sheet 01 of 01

Designed	S Banerjee	SB	Eng. Check	G Rossi	GR
Drawn	S Kale	SK	Coordination	L Thomas	LT
Dwg. Check	G Rossi	GR	Approved	P Lear	PL

MMD Project Number 104560	Scale at A1 1:500	Security STD
Client Number 004369956		Suit. Code S3
Drawing Number 104560-MMD-00-XX-DR-E-0008		Rev 03



OVERALL SITE LAYOUT -GIS

1 : 500

Table of Clearances

400kV System

In accordance with NG TS 2.1

- Phase to Earth (PE)	2.8m
- Phase to Phase (PP)	3.6m
- Minimum Insulation Height	2.4m
- Minimum Safety Distance (SD)	3.1m
- Design Clearance of Safety (Horizontal)HSC	4.6m
- Design Clearance of Safety (Vertical) VSC	5.5m

275kV System

In accordance with NG TS 2.1

- Phase To Earth (PE)	2.1m
- Phase To Phase (PP)	2.4m
- Minimum Insulation Height*	2.4m
- Minimum Safety Distance (SD)*	2.4m
- Design Clearance of Safety (Horizontal) HSC	3.9m
- Design Clearance of Safety (Vertical) VSC	4.8m

132kV SYSTEM

In accordance with NG TS 2.1

- Phase To Earth (PE)	1.1m
- Phase To Phase (PP)	1.4m
- Minimum Insulation Height*	2.4m
- Minimum Safety Distance (SD)*	1.4m
- Design Clearance of Safety (Horizontal) HSC	2.9m
- Design Clearnace of Safety (Vertical) VSC	3.8m

Abbreviations:

CSE	-Cable Sealing End
SA	-Surge Arrestors
ES	-Earth Switch
P.DISC.	-Pantograph Type Disconnector
DISC.	-Rotating Type Disconnector
CB	-Circuit Breaker
PI	-Post Insulator
CT	-Current Transformer
WVT	-Wound Voltage Transformer
SGT	-Super Grid Transformer
SVC	-Static VAR Compensator
TBC	-To Be Confirmed
GIS	-Gas Insulator Switchgear
VSC	-Voltage Source Converter
STATCOM	-Static Synchronous Compensator
SH.REAC.	-Shunt Reactor
LM	-Lightning Masts
TBCa	-To Be Calculated
LC	-Lighting Columns

400kV GIS Bays Building Schedule

Bay Nomenclature	Descriptions
F-4.1	400kV Shunt Reactor 100MVAr
F-4.2	To National Grid 400kV Substation
F-4.3	SGT1, 400/132/33KV 550/550/180 MVA
F-4.4	400kV Harmonic Filter
F-4.5	SGT2, 400/132/33KV 550/550/180 MVA

132kV GIS Bays Building Schedule

Bay Nomenclature	Descriptions
F-1.1	Shunt Reactor 1a 60MVAr
F-1.2	Offshore Export Cable 1
F-1.3	Shunt Reactor 1b 60MVAr
F-1.4	Bus Coupler 1
F-1.5	Shunt Reactor 2a 60MVAr
F-1.6	Offshore Export Cable 2
F-1.7	Shunt Reactor 2b 60MVAr
F-1.8	Harmonic Filter-1
F-1.9	SGT1, 400/132/33KV 550/550/180 MVA
F-1.10	Main Bus Section 1
F-1.11	Reserve Bus Section 1
F-1.12	SGT2, 400/132/33KV 550/550/180 MVA
F-1.13	Harmonic Fiter-2
F-1.14	Shunt Reactor 3a 60MVAr
F-1.15	Offshore Export Cable 3
F-1.16	Shunt Reactor 3b 60MVAr
F-1.17	Bus Coupler 2
F-1.18	Shunt Reactor 4a 60MVAr
F-1.19	Offshore Export Cable 4
F-1.20	Shunt Reactor 4b 60MVAr

Notes

1. Dimension is in mm unless stated otherwise.
2. This layout is indicative only. The following aspects shall be considered when developing the design:
   - Magnetic clearance from the air core reactors
   - Fire Suppression Systems
   - Site Lighting and Security Systems
   - Pedestrain Access requirement to equipment / building.
   - Lightning Protection
3. The equipment appearance and size shown are indicative only.
4. Reactive compensation equipment and Harmonic Filters are indicative only.
5. Water supplies for the fire fighting purposes to be made available for the use by the Fire Bridge (Hydrant to be provided within 90m of all the equipment and buildings)
6. The following fencing requirements have been assumed:
   Internal Fence: 2.4M High non-electric fence
   Perimeter Fence: 3.4M High Physical Mesh / Palisade Barrier with Electric Pulse Fence.
7. DNO cabinet and substation are indicative only. Location shall be agreed and confirmed by the distributor.
   Indicative heights of the building and main equipment:
   - Power transformer noise enclosure : 7M
   - GIS Building 400kV : 15M
   - GIS Building 132kV: 15M
   - GIS Building Annex (400kV & 132kV): 9M
   - STATCOM building: 7M
   - Harmonic Filter: 12.5M
   - Storage building: 4M
   - Control building: 5M
   - Shunt Reactor noise enclosure: 7M
   - Diesel Generator: 5M
8. Overall substation compound footprint is 4.62 hectares (46,300 sqm)
9. The GIS building will be provided with an undercroft.Cables can be routed as the design requires using undercroft.Cable routes shall be designed and confirmed in next design stages.
10. Ratings of equipment for reactive compensation is indicative and based on the allowed footprint.Actual equipment rating required shall be confirmed by system studies.
11. Noise enclosure on transformers and shunt reactors is fitted around the transformer tank only.
12. Export voltage GIS Buildings sized to accomodate SF6 free switchgear up to 275kV.
13. Access gate location is indicative and shall be confirmed depending on permanent site access requirement.
14. Lighting column number and location is indicative only and shall be confirmed by lighting study.

Key to symbols

- Indicative Fire Damage Zone
- Indicative Internal Fence
- Indicative External Fence
- Indicative 18m Lightning Mast Location
- Lighting Column - 6m high (Note 14)

Reference drawings

004369953	Single Line Diagram -GIS
004369957	Elevations of Substation Compound - GIS

Rev	Date	Drawn	Description	Ch'k'd	App'd
04	30.09.22	SRK	Updated as per Client Comments	GR	PL
03	09.09.22	SRK	Revised As Per Client Comments	GR	PL
02	12.08.22	SRK	Revised As Per Client Comments	GR	PL
01	15.07.22	SRK	Preliminary Issue	GR	PL

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Client

FIVE ESTUARIES OFFSHORE WIND FARM

Title

FIVE ESTUARIES WIND FARM ONSHORE SUBSTATION ELECTRICAL LAYOUT - GIS OPTION

Sheet 01of 01

Designed	S Banerjee	SB	Eng. Check	G Rossi	GR
Drawn	S Kale	SRK	Coordination	Laby Thomas	LT
Dwg. Check	G Rossi	GR	Approved	P Lear	PL

MMD Project Number: 104560	Scale at A1: 1:500	Security: STD
Client Number: 004369955		Suit. Code: S3
Drawing Number: 104560-MMD-00-XX-DR-E-0007		Rev: 04

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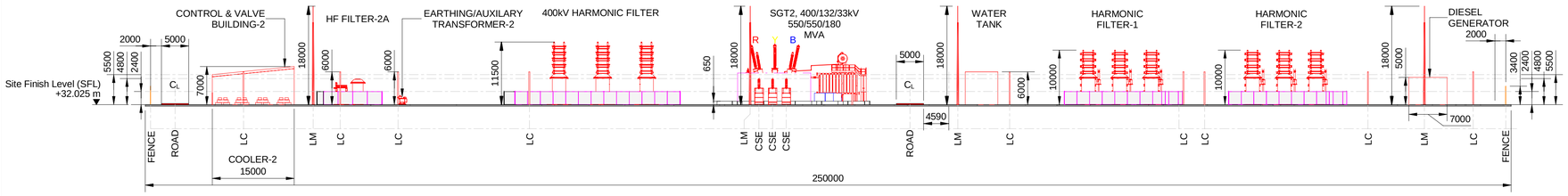
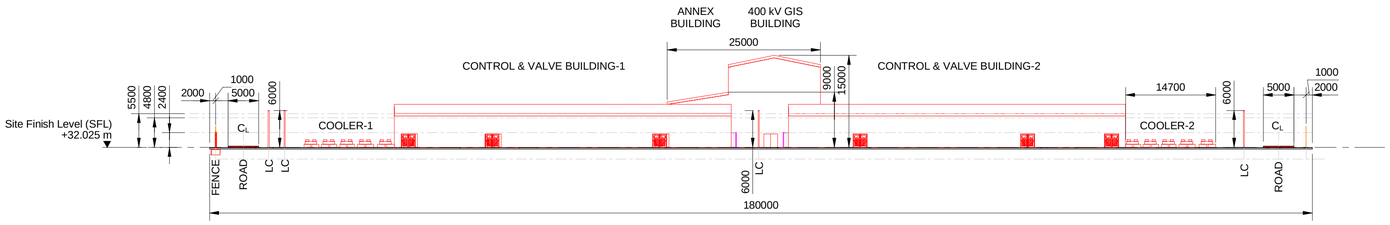
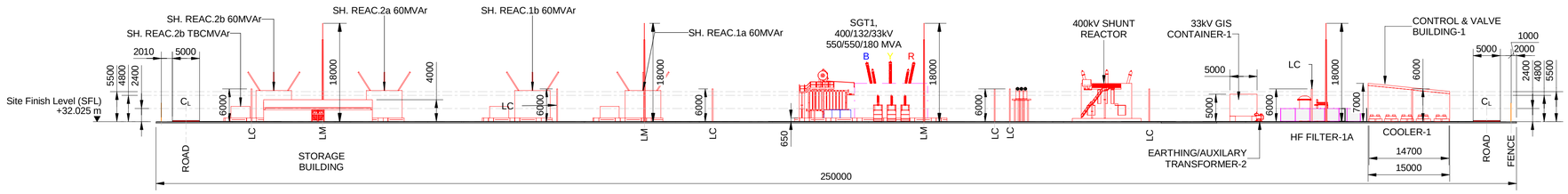


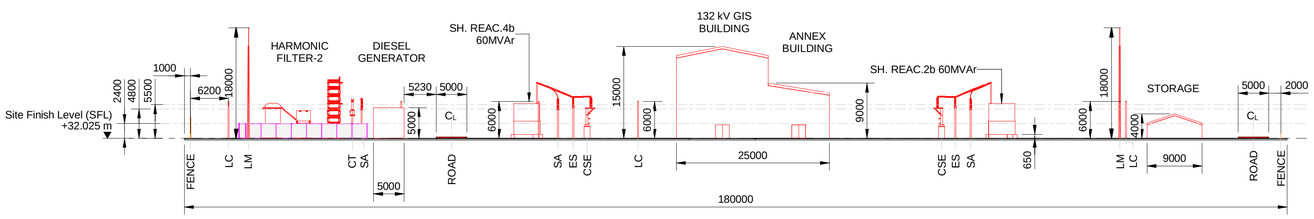
ELEVATION A
1 : 500
E-0007



ELEVATION B
1 : 500
E-0007



ELEVATION C
1 : 500
E-0007



ELEVATION D
1 : 500
E-0007

Table of Clearances

400kV System

In accordance with NG TS 2.1

- Phase to Earth (PE)	2.8m
- Phase to Phase (PP)	3.6m
- Minimum Insulation Height	2.4m
- Minimum Safety Distance (SD)	3.1m
- Design Clearance of Safety (Horizontal)HSC	4.6m
- Design Clearance of Safety (Vertical) VSC	5.5m

275kV System

In accordance with NG TS 2.1

- Phase To Earth (PE)	2.1m
- Phase To Phase (PP)	2.4m
- Minimum Insulation Height*	2.4m
- Minimum Safety Distance (SD)*	2.4m
- Design Clearance of Safety (Horizontal) HSC	3.9m
- Design Clearance of Safety (Vertical) VSC	4.8m

132kV SYSTEM

In accordance with NG TS 2.1

- Phase To Earth (PE)	1.1m
- Phase To Phase (PP)	1.4m
- Minimum Insulation Height*	2.4m
- Minimum Safety Distance (SD)*	1.4m
- Design Clearance of Safety (Horizontal) HSC	2.9m
- Design Clearnace of Safety (Vertical) VSC	3.8m

Abbreviations:

CSE	-Cable Sealing End
SA	-Surge Arrestors
ES	-Earth Switch
P.DISC.	-Pantograph Type Disconnector
DISC.	-Rotating Type Disconnector
CB	-Circuit Breaker
PI	-Post Insulator
CT	-Current Transformer
WVT	-Wound Voltage Transformer
SGT	-Super Grid Transformer
SVC	-Static VAR Compensator
TBC	-To Be Confirmed
GIS	-Gas Insulator Switchgear
VSC	-Voltage Source Converter
STATCOM	-Static Synchronous Compensator
SH.REAC.	-Shunt Reactor
LM	-Lightning Masts
TBCa	-To Be Calculated
LC	-Lighting Columns

Notes

1. Dimension is in mm unless stated otherwise.
2. This layout is indicative only. The following aspects shall be considered when developing the design:
   - Magnetic clearance from the air core reactors
   - Fire Suppression Systems
   - Site Lighting and Security Systems
   - Pedestrain Access requirement to equipment / building.
   - Lightning Protection
3. The equipment appearance and size shown are indicative only.
4. Reactive compensation equipment and Harmonic Filters are indicative only.
5. Water supplies for the fire fighting purposes to be made available for the use by the Fire Bridge (Hydrant to be provided within 90m of all the equipment and buildings)
6. The following fencing requirements have been assumed:
   Internal Fence: 2.4M High non-electric fence
   Perimeter Fence: 3.4M High Physical Mesh / Palisade Barrier with Electric Pulse Fence.
7. DNO cabinet and substation are indicative only. Location shall be agreed and confirmed by the distributor.
   Indicative heights of the building and main equipment:
   - Power transformer noise enclosure : 7M
   - GIS Building 400kV: 15M
   - GIS Builing 132kV: 15M
   - GIS Building Annex (400kV & 132kV) : 9M
   - STATCOM building: 7M
   - 400kV Harmonic Filter: 12.5M
   - 132kV Harmonic Filter: 10M
   - Storage building: 4M
   - Control building: 5M
   - Shunt Reactor noise enclosure: 7M
   - Diesel Generator: 5M
8. The GIS building will be provided with an undercroft.Cables can be routed as the design requires using undercroft.Cable routes shall be designed and confirmed in next design stages.
10. Ratings of equipment for reactive compensation is indicative and based on the allowed footprint.Actual equipment rating required shall be confirmed by system studies.
11. Noise enclosure on transformers and shunt reactors is fitted around the transformer tank only.
12. Export voltage GIS Buildings sized to accomodate SF6 free switchgear up to 275kV.

Key to symbols

Reference drawings

004369953	Single Line Diagram -GIS
004369955	Overall Site Layout -GIS

Rev	Date	Drawn	Description	Ch'k'd	App'd
03	30.09.22	SRK	Updated as per Client Comments	GR	PL
02	09.09.22	SRK	Revised As Per Client Comments	GR	PL
01	12.08.22	SRK	Preliminary Issue	GR	PL

Status Stamp

FOR REVIEW

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Client

FIVE ESTUARIES OFFSHORE WIND FARM

Title

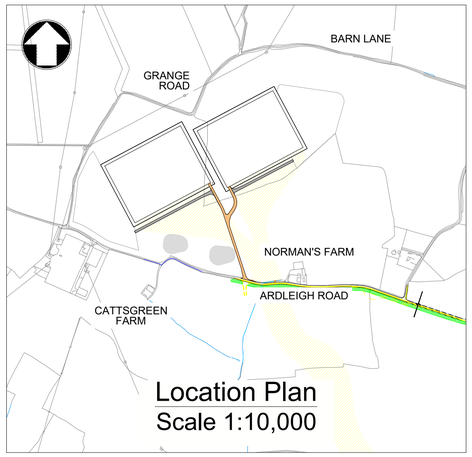
FIVE ESTUARIES WIND FARM ONSHORE SUBSTATION ELEVATIONS OF SUBSTATION COMPOUND- GIS OPTION Sheet 01of 01

Designed	S Banerjee	SB	Eng. Check	G Rossi	GR
Drawn	S Kale	SRK	Coordination	Laby Thomas	LT
Dwg. Check	G Rossi	GR	Approved	P Lear	PL

MMD Project Number 104560	Scale at A1 1:500	Security STD
Client Number 004369957		Suit. Code S3
Drawing Number 104560-MMD-00-XX-DR-E-0009		Rev 03

1:500 0 25m 50m

ANNEX B: OUTLINE OPERATIONAL DRAINAGE LAYOUT



Location Plan
Scale 1:10,000

Plan
Scale 1:2,000

Legend:

- Permanent Substation Compound
- Permanent swale/infiltration ditch (see Note 22)
- Permanent Access Road (material to be confirmed)
- Permanent Access Overrun Area
- Paved Area (tarmac) of the Permanent Access to Substation
- Permanent Pond and Grading
- Temporary Access Road
- Temporary Construction Compound
- Temporary swale/infiltration ditch (see Note 22)
- Temporary Pond and Grading
- Design flow exceedence route (see note 23)
- Existing Watercourse (see Note 4)
- Existing Ditch
- Existing Ditch, Planned to Fill In
- Permanent Ditch Diversion
- Proposed Cable Swathe Routes (see Note 25)
- Cable Route Corridor Zone
- Permanent Headwall
- Permanent Catchpit
- Catchpit with vortex flow control device (see Note 10)
- Permanent Culvert Crossing
- Permanent Carrier Pipe
- Permanent Filter Drain Pipe
- Permanent Fenceline
- Temporary Headwall
- Temporary Chamber
- Temporary Carrier Pipe
- Temporary Filter Drain/Ditch
- Temporary Culvert Crossing
- xx.xxxm — Permanent/FGL Spot Level
- xx.xxxm — LiDAR Contours
- TPXX xx.xxxm — Ground Investigation Trial Pit Location
- z xx.xxx — Existing Ground Water Level (see Note 24)
- xx.xxx — Lowest proposed level in compound
- xx.xxx — Lowest existing ground level in pond
- HV–D HV–D — High Voltage Utility
- HV/OH–D — High Voltage Overhead Utility
- BT–D BT–D — BT Utility
- BTR–D — Buried Water Utility

Reference drawings

OS map
SOCOTEC UK Draft Trial Pit Logs (Dug 19th May 2023)
Technics Digitised Utility Report Information
104560-MMD-00-XX-DR-CE-1004 - Site Layout/ Location Plan - AIS Option 2
104560-MMD-00-XX-DR-CE-1006 - AIS Substation Earthworks Plan and Long Section - Project 1 & 2
104560-MMD-00-XX-DR-CE-1007 - Temporary Compound Earthworks Plan and Long Section - Project 1
104560-MMD-00-XX-DR-CE-1009 - Temporary Compound Earthworks Plan and Long Section - Project 2
104560-MMD-00-XX-DR-CE-1015 - Permanent Access Layout
104560-MMD-00-XX-DR-CE-1017 - Temporary Accesses to Construction Compounds (Option 2) Layout
104560-MMD-00-XX-DR-EE-1030 - Electrical Site Layout - AIS
104560-MMD-00-XX-DR-CE-1061 - Permanent and Temporary Access Junction with Ardleigh Road

Notes:

1. DO NOT SCALE FROM THIS DRAWING.
2. ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS IN METRES AOD (RELATIVE TO ORDNANCE DATUM NEWLYN) UNLESS OTHERWISE STATED.
3. MOTT MACDONALD TAKE NO LIABILITY FOR THE INFORMATION PROVIDED BY OTHERS UPON WHICH THIS DRAWING IS BASED.
4. EXISTING WATERCOURSES BASED ON OS DATA. © CROWN COPYRIGHT AND DATABASE RIGHTS 2022 ORDNANCE SURVEY (0100031673).
5. ANY DRAWING ERRORS OR DISCREPANCIES SHOULD BE BROUGHT TO THE ATTENTION OF MOTT MACDONALD.
6. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT DOCUMENTS AND DRAWINGS (SEE REFERENCE DRAWINGS LIST).
7. NO UN-AUTHORISED DISCLOSURE, STORAGE OR COPYING.
8. ALL SUDS (DRAINAGE SYSTEMS INCLUDING ATTENUATION BASINS, PONDS, SWALES ETC.) ARE TO BE CONSTRUCTED IN ACCORDANCE WITH CIRIA753, THE SUDS MANUAL 2015.
9. ALL SPATIAL COORDINATES RELATE TO THE ORDNANCE SURVEY, BRITISH NATIONAL GRID (OSGB36).
10. MAXIMUM PASS FORWARD FLOW 1 LITRE PER SECOND FROM EACH PROJECT. REFER TO THE DRAINAGE STRATEGY FOR DETAILS. (104560-MMD-00-XX-RP-CE-1010 CIV RWE CO-LOCATED SUBSTATION EARLY DESIGN - DRAINAGE STRATEGY)
11. FEH METHOD DESIGN CRITERIA AND CV COEFFICIENT FOR WINTER SET 1.0.
12. PIPES TO BE ENCASED IN CONCRETE WHEN MINIMUM COVER < 1200MM UNDER ACCESS ROADS.
13. ACCESS ROADS TO BE PROVIDED WITH A CAMBER/ CROSSFALL AND DISCHARGE TO PROPOSED FILTER DRAIN.
14. FOUL TANK OR TREATMENT PLANTS TO BE LOCATED WITHIN THE PERMAMENT AND CONSTRUCTION COMPOUNDS TO COLLECT FOUL WATER (NOT INDICATED ON DRAWINGS). TANK SIZES, LOCATION AND CONNECTION POINT TBC.
15. REFER TO 104560-MMD-00-XX-DR-EE-1030 ELECTRICAL SITE LAYOUT - AIS FOR INTERNAL DETAILS OF ELECTRICAL SUBSTATION LAYOUT.
16. CONTAMINATION TO BE ASSESSED AS PART OF THE GEOTECHNICAL INVESTIGATIONS TO ENSURE POLLUTANT PATHWAYS ARE NOT CREATED BY INFILTRATION THROUGH CONTAMINATED MATERIALS.
17. ALL PERMANENT DRAINAGE SHOWN ON THE DRAWING TO REMAIN FOR THE OPERATIONAL PHASE.
18. ALL TEMPORARY DRAINAGE SHOWN ON THE DRAWING TO BE REMOVED FOR THE OPERATIONAL PHASE.
19. CONTOURS BASED ON EA 1M DTM LIDAR ACCESSED DECEMBER 2022.
20. FLOOD STORAGE VOLUMES BASED ON RESTRICTING RUNOFF RATES FOR THE 1 IN 100 YEAR EVENT (+45% ALLOWANCE FOR CLIMATE CHANGE) FOR THE PERMANENT CASE AND FOR THE 1 IN 5 YEAR EVENT (+10% ALLOWANCE FOR CLIMATE CHANGE) IN THE TEMPORARY CONSTRUCTION CASE. REQUIREMENT FOR PERMANENT TREATMENT VOLUME (VT) BELOW FLOOD STORAGE DEPTH TO BE CONFIRMED DURING SUBSEQUENT DESIGN STAGES.
21. EXACT LAYOUT OF PERMANENT PLATFORM AND TEMPORARY CONSTRUCTION COMPOUNDS, INCLUDING FINISHED LEVELS, INTERNAL DRAINAGE ARRANGEMENTS AND ACCESS ROADS TO BE CONFIRMED DURING SUBSEQUENT DESIGN STAGES.
22. INFILTRATION TESTING TO BE CARRIED OUT DURING SUBSEQUENT DESIGN STAGES AND OPTION TO REDUCE OR REMOVE ATTENUATION PONDS AND USE SWALES FOR DIRECT INFILTRATION TO BE CONSIDERED. REFER TO DRAINAGE STRATEGY FOR FURTHER DETAILS.
23. EXACT EXCEEDENCE ROUTE TO BE CONFIRMED USING TOPOGRAPHICAL SURVEY. PROVISION OF BUNDS MAYBE REQUIRED TO DIRECT WATER AWAY FROM FARM ACCESS AND BUILDINGS.
24. INDICATIVE GROUNDWATER LEVEL BASED ON DRAFT TRIAL PITS DUG MAY 2023.
25. EXACT CABLE SWATHE ROUTE TO BE CONFIRMED (INCLUDING DECONFLICTION WITH DRAINAGE FEATURES) DURING SUBSEQUENT DESIGN STAGES.
26. DUE TO GENERALLY FLAT TOPOGRAPHY OF THE SITE IT IS LIKELY THAT SURFACE WATER FILTER DRAINS AND CARRIER PIPES WILL NEED TO BE LAID AT SHALLOW GRADIENTS WHERE RECOMMENDED MINIMUM SELF-CLEANSING VELOCITIES MAY NOT BE ACHIEVABLE. THEREFORE MORE FREQUENT INSPECTION AND CLEANING OF PIPELINES MAYBE REQUIRED.

Rev	Date	Drawn	Description	Ch'k'd	App'd
06	08/03/2024	YV	Updated to address client comments	TN	AFC
05	04/03/2024	CT	Updated to address client comments	TN	AFC
04	24/01/2024	YV	Updated to address client comments	JWD	AFC
03	18/09/2023	CT	Updated to address client comments	TN	AFC
02	01/08/2023	CT	Client's comments incorporated	TN	JW
01	15/06/2023	YV	Preliminary	AL	MB

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Client

NORTH FALLS Offshore Wind Farm
FIVE ESTUARIES OFFSHORE WIND FARM

Title

Co-located AIS Substations Early Design - Drainage Layout - Operational Phase - Option 2

Sheet 01 of 01

Designed	Charlotte Tyler	CT	Eng check	Amy Lambourne	AL
Drawn	Laura Snowden	LS	Coordination	Andrea F. Crespo	AFC
Dwg check	Thomas North	TN	Approved	Matthew Barton	MB

MMD Project Number	Scale at A1	Security
104560-001	As Indicated	STD
Client Number		Suit. Code
004809399-06		S3
Drawing Number		Revision
104560-MMD-00-XX-DR-CE-1011		06

1:2000 0 100m 200m

1:10,000 0 500m 1000m

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