Salamander Offshore Wind Farm

Offshore EIA Report

Volume ER.A.2, Chapter 4: Project Description

SALAMANDER

Powered by Ørsted and Simply Blue Group

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Glossary

Term	Definition
Applicant	Salamander Wind Project Company (formerly called Simply Blue Energy (Scotland) Limited), a joint venture between Ørsted, Simply Blue Group and Subsea7.
Construction Compounds	Compounds associated with the onshore works, including landfall compound, which may include elements such as hard standings, lay down and storage areas for construction materials and equipment, areas for vehicular parking, welfare facilities, connection to services (including water and electricity) where possible within the intended Development Area, wheel washing facilities, workshop and office facilities and temporary fencing or other means of enclosure.
Design Envelope	A description of the range of possible elements that make up the Salamander Project design options under consideration, as set out in detail in the project description. This envelope is used to define the Salamander Project for Environmental Impact Assessment (EIA) purposes when the exact engineering parameters are not yet known.
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the importance, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
Energy Balancing Infrastructure (EBI)	Energy Balancing Infrastructure which will provide services to the electrical grid, such as storing energy to meet periods of peak demand and improving overall reliability, as well as additional services such as system monitoring and computing. EBI will be housed within buildings and / or containers will be co-located with the Onshore Substation.
Environmental Impact Assessment (EIA)	A statutory process by which the likely significant effects of certain projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the Environmental Impact Assessment (Scotland) Regulations, including the publication of an Environmental Impact Assessment Report (EIAR).
EIA Regulations	The regulations that apply to this project are the Electricity Works (EIA) (Scotland) Regulations 2017, the Marine Works (EIA) (Scotland) Regulations 2017, the Marine Works (EIA) Regulations 2007, and the Town and Country Planning (EIA) (Scotland) Regulations 2017.
Environmental Impact Assessment Report (EIAR)	A document reporting the findings of the EIA and produced in accordance with the EIA Regulations.

Export Cable Corridor (ECC)	The specific corridor of seabed (seaward of Mean High Water Springs (MHWS)) and land (landward of MHWS) from the Offshore Array Area to the Onshore Substation, within which the export cables will be located.
Haul Road	The track along the onshore ECC which the construction traffic would use to access work fronts
Horizontal directional drilling (HDD)	A trenchless method of cable installation where the duct (or ducts) is installed to allow the cable(s) to be installed at a later date.
Impact	An impact is considered to be the change to the baseline as a result of an activity or event related to the Salamander Project. Impacts can be both adverse or beneficial impacts on the environment and be either temporary or permanent.
Inter-array Cables	Offshore cables which link the wind turbines to each other and to the Offshore Export Cable(s).
INTOG Leasing Round	The Innovation and Targeted Oil and Gas (INTOG) leasing round where developers apply for the rights to build offshore wind farms specifically for the purpose of providing low carbon electricity to power oil and gas installations and help to decarbonise the sector.
Joint Bay	Underground structures constructed at intervals along the Onshore Export Cable route to facilitate joining of cable sections or lengths.
Long-term	Of several years or decades, accounting for year to year variations.
Landfall	The generic term applied to the entire landfall corridor between Mean Low Water Spring (MLWS) tide and the Transition Joint Bay (TJB) inclusive of all construction works, including the offshore and onshore Export Cable Corridor, and landfall compound, where the offshore cables come ashore north of Peterhead.
National electricity grid	The high voltage electricity transmission network in Scotland is owned and maintained by the Great Britain Transmission Network Operator. This will be Scottish and Southern Electricity Networks (SSEN) for the location of the Salamander Project.
Offshore Array Area	The offshore area within which the wind turbine generators, foundations, mooring lines and anchors, and inter-array cables and associated infrastructure will be located.
Offshore Development	The entire Offshore Development, including all offshore components of the Project (WTGs, Inter-array and Offshore Export Cable(s), floating substructures, mooring lines and anchors, and all other associated offshore infrastructure) required across all Project phases from development to decommissioning, for which the Applicant is seeking consent.

Offshore Development Area	The total area comprising the Offshore Array Area and the Offshore Export Cable Corridor.
Offshore Export Cable(s)	The export cable(s) that will bring electricity from the Offshore Array Area to the Landfall. The cable(s) will include fibre optic cable(s).
Offshore Export Cable Corridor	The area that will contain the Offshore Export Cable(s) between the boundary of the Offshore Array Area and Mean High Water Springs (MHWS).
Onshore Development	The entire Onshore Development, including Construction Compounds at the Landfall, temporary working areas, Onshore Export Cables, Transition Joint Bay, Joint Bays, Onshore Substation and Energy Balancing Infrastructure, Construction Compounds, any associated landscaping (if required) and access (and all other associated infrastructure) across all Project phases from development to decommissioning, for which the Applicant is seeking consent.
Onshore Development Area	The total area comprising the Landfall, Onshore Export Cable Corridor, and Onshore Substation, EBI and associated infrastructure.
Onshore Export Cables	The export cables which will bring electricity from Landfall to the Onshore Substation.
Onshore Export Cable Corridor	The area within which the Onshore Export Cables will be located, as well as temporary Construction Compounds which includes cable trenches, haul road, excavated material and storage areas.
Onshore Substation	Comprises a compound containing the electrical components for transforming the power supplied from the Salamander Project to 132 kV and to adjust the power quality and power factor, as required to meet the UK Grid Code for supply to the National Grid. The onshore substation is also the compound in which EBI and associated infrastructure will be co-located.
Receptor	Any physical, biological or anthropogenic element of the environment that may be affected or impacted by the Salamander Project. Receptors can include natural features such as the seabed and wildlife habitats as well as man-made features like fishing vessels and cultural heritage sites.
Safety zones	A marine area declared for the purposes of safety around a renewable energy installation or works/ construction area under the Energy Act 2004.
Salamander Project	The proposed Salamander Offshore Wind Farm. The term covers all elements of both the offshore and onshore aspects of the project.

Scoping	An early part of the EIA process by which the key potential significant impacts of the Salamander Project are identified, and methodologies identified for how these should be assessed. This process gives the relevant authorities and key consultees opportunity to comment and define the scope and level of detail to be provided as part of the EIAR – which can also then be tailored through the consultation process.
Scour protection	Protective materials to avoid sediment being eroded away from the base of the seabed infrastructure as a result of the flow of water.
Semi-Submersible	A Semi-Submersible structure is a buoyancy-stabilised platform which floats partially submerged on the surface of the ocean whilst anchored to the seabed. The structure gains its stability through the distribution of buoyancy force associated with its large footprint and geometry which ensures the wind loading on the structure and turbine are countered by an equivalent buoyancy force on the opposite side of the structure. Included in the Project Design Envelope, there are variations of the semi-submersible concept, such as barge, buoy, or hybrid.
Tension Leg Platform	A Tension Leg Platform is a semi-submerged buoyant structure, anchored to the seabed with tensioned mooring lines. The combination of the structure buoyancy and tension in the anchor/mooring system provides the platform stability. This system-driven stability (as opposed to the stability coming just from the floating substructure itself) allows for a comparatively smaller and lighter structure compared to Semi-Submersible equivalents.
Transition Joint Bay (TJBs)	Underground structures at the landfall that house the joints between the Offshore Export Cable(s) and Onshore Export Cable(s).
Trenched methods	Trenched methods, such as open cut, involves the excavation of a trench and the installation of a cable or duct. The trench is then backfilled onshore, whereas offshore the trench may be either backfilled or left to infill naturally, though this is dependent on seabed conditions.
Trenchless methods	Also referred to as trenchless crossing techniques or trenchless methods. These techniques include Horizontal Directional Drilling (HDD), thrust boring, auger boring, pipe jacking and arc drilling, which allow ducts to be installed under an obstruction without breaking open the ground and digging a trench.
Wind Turbine Generator	All the components of a wind turbine, including the tower, nacelle, and rotor.

Acronyms

Term	Definition
ADCP	Acoustic Doppler Current Profiler
AIS	Automatic Identification System
AtoN	Aids to Navigation
bl	Blows
CAA	Civil Aviation Authority
CBRA	Cable Burial Risk Assessment
cm	Centimetre
CMS	Construction Method Statement
CPT	Cone Penetration Tests
CTV	Crew Transport Vessel
DP	Direct Pipe
DS	Design Statement
DSLP	Design Specification and Layout Plan
EBI	Energy Balancing Infrastructure
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
ELF	Extremely Low Frequency
EMF	Electro-Magnetic Field
EPS	European Protected Species
ES	Environmental Statement

FLOW	Floating Offshore Wind
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HSE	Health, Safety and Environment
hr	Hour
HV	High Voltage
HVAC	High Voltage Alternating Current
Hz	Hertz
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICPC	International Cable Protection Committee
INTOG	Innovation and Targeted Oil and Gas
JIP	Joint Industry Project
kg	Kilogram
kJ	Kilojoule
km	Kilometre
kV	Kilovolt
l	Litre
LAT	Lowest Astronomical Tide
LiDAR	Light Detection and Ranging
LMP	Lighting and Marking Plan
m	Metre
MCA	Maritime and Coastguard Agency
MD-LOT	Marine Directorate - Licensing Operations Team
MFE	Mass Flow Excavation

MHWS	Mean High Water Springs
MGN	Marine Guidance Note
µT	Microtesla
MLWS	Mean Low Water Springs
mm	Milimetre
MoD	Ministry of Defence
MW	Megawatt
NEQ	Net Explosive Quantity
NLB	Northern Lighthouse Board
NtM	Notice to Mariners
NZTC	Net Zero Technology Centre
O&M	Operation and Maintenance
ODN	Ordnance Datum Newlyn
OMP	Operation and Maintenance Programme
OnSS	Onshore Substation
OREI	Offshore Renewable Energy Installation
PLGR	Pre-lay Grapnel Run
PS	Piling Strategy
QHSE	Quality, Health, Safety and Environment
ROV	Remotely Operated Vehicle
SCADA	Supervisory Control and Data Acquisition
SMEEF	Scottish Marine Environmental Enhancement Fund
SLVIA	Seascape and Landscape Visual Impact Assessment
SOV	Service Operation Vessel

SS	Semi-Submersible
SSEN	Scottish and Southern Electricity Networks
SWL	Still Water Level
SWPC	Salamander Wind Project Company Limited (formerly called SBES)
TBM	Tunnel Boring Machine
TJB	Transition Joint Bay
TLP	Tension Leg Platform
UKHO	UK Hydrographic Office
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator

4 Project Description

4.1 Introduction

4.1.1.1 The Applicant, Salamander Wind Project Company Limited (SWPC) (the Applicant) a joint venture (JV) partnership between Ørsted, Simply Blue Group and Subsea7, is proposing the development of the Salamander Offshore Wind Farm (hereafter 'Salamander Project'). The Salamander Project will consist of the installation of a floating offshore wind farm (up to 100 megawatts (MW) capacity) approximately 35 kilometres (km) east of Peterhead. It will consist of both offshore and onshore infrastructure, including an offshore generating station (wind farm), export cables to landfall, and connection to the onshore substation.

4.1.1.2 This chapter presents a description of the design of the offshore aspects of the Salamander Project up to Mean High Water Springs (MHWS); the Offshore Development. It sets out the components of the offshore infrastructure, as well as the activities associated with construction, operation and maintenance, and decommissioning.

4.1.1.3 A Design Envelope approach has been used to include sufficient flexibility to accommodate further project refinement during detailed design as well as during construction, operation and decommissioning. This chapter therefore sets out a series of options and parameters for the project's design. The final design will be refined after consent has been granted from within the limits of the parameters stated in this Project Description.

4.2 Design Envelope Approach

4.2.1.1 The Environmental Impact Assessment Report (EIAR) presents a Design Envelope within which the final detailed design of the Offshore Development will fall. The Design Envelope forms the basis upon which the impact assessments have been assessed, including consideration of embedded mitigation. Embedded mitigation measures are those that are built into the Salamander Project concept, either through design (primary mitigation) or implementation of industry best practice (tertiary mitigation); further detail on the approach to mitigation is provided in **Volume ER.A.2, Chapter 6: EIA Methodology**.

4.2.1.2 The final project design will depend on factors including ground conditions, wave and tidal conditions, project economics and procurement approach. Due to the complex nature of the development many of the final details of the proposed scheme are likely to be unknown at the time of application such as:

- Precise location and configuration of turbines;
- Floating foundation type;
- Mooring system;
- Inter-array cable layout;
- Exact turbine hub height;
- Cable type and cable route; and
- Exact location of the onshore substation, Scottish and Southern Electricity Networks (SSEN) infrastructure and any energy balancing infrastructure such as battery storage (though this will be detailed and assessed within the Onshore EIAR).

4.2.1.3 This chapter therefore sets out the realistic worst-case design parameters for the Offshore Development, which are encompassed within the Design Envelope.

4.2.1.4 The use of the Design Envelope approach for the Salamander Project is reflective of the Marine Scotland's[1] Consenting and Licensing Guidance for Offshore Wind, Wave and Tidal Energy Applications (The Scottish Government, 2018). The manual explains the approach under Section 36 of the Electricity Act 1989 and the process for Environmental Impact Assessment (EIA) set out in The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017.

4.2.1.5 The Design Envelope approach (also known as Rochdale Envelope) was developed during onshore planning applications to provide flexibility in design options where details of the whole project are not available when the application is submitted, while ensuring the impacts of the final development are fully assessed during the EIA. Consents granted based on the Design Envelope are granted conditional for final details to be approved prior to construction.

4.2.1.6 This is consistent with the Marine Scotland's Consenting and Licensing manual (section 3.2) which states:

"Due to the frequent advances in technology development of equipment, and the nature of the design process, for offshore renewable energy projects, developers may not be able to provide precise design details in their consent applications. Some flexibility in the project description is acceptable, provided that the approach is fully described in the EIA Report to allow Scottish Ministers and consultees to fully understand the implications of the flexibility proposed."

4.2.1.7 The manual also states:

"At the time of application, any proposed flexibility in scheme parameters should not be so wide ranging as to represent effectively different types of project. The degree of flexibility in design parameters will need to be clearly defined in the application and EIA Report."

4.2.1.8 Further guidance published by Marine Scotland and the Energy Consents Unit for applicants on using the design envelope for applications under Section 36 of the Electricity Act 1989 (The Scottish Government, 2022a) (section 7.2) states that when applicants use the design envelope approach:

"It is expected that applicants ensure that:

- *their approach is explained clearly for the purpose of consultation and publicity, including pre-application consultation;*
- *the application documentation clearly defines the proposal and is sufficiently detailed to enable proper consideration and comment by stakeholders, and determination of the application;*
- *the EIA report explains fully how the flexibility sought has been taken into account in the assessments and why it is required; and*
- *there is consistency across all the application documents including any other relevant environmental assessments."*

4.2.1.9 Throughout the EIA the Design Envelope approach has been taken to allow meaningful assessments of the Salamander Project to proceed, whilst still allowing reasonable flexibility for future design decisions.

4.2.2 Relationship to the Realistic Worst-case Design Scenario

4.2.2.1 In order to avoid excessive conservatism in the EIA, the parameters assessed throughout the assessments are not necessarily a combination of the maximum design parameters for each component. Hence the

1 Marine Scotland is now known as Marine Directorate, but the consenting manual was published whilst the department was Marine Scotland, and so is referenced as such.

worst-case design scenario is chosen on a receptor by receptor and an impact-by-impact basis, based on a range of build-out scenarios.

4.2.3 Turbine Capacity

4.2.3.1 The EIA is not linked directly to the wind turbine generator (WTG) capacity, but rather its physical dimensions such as tip height and rotor diameter. In recent years, the capacity of WTGs has become more flexible and may be different depending on environmental conditions at the sites. Historically, constraining the upper megawatt (MW) capacity limit for WTGs has resulted in the need for numerous non-material change applications, such as Seagreen Alpha / Bravo in 2018, Moray East in 2019, and both Inch Cape and Moray West in 2021.

4.2.3.2 It is therefore not considered necessary to constrain the Design Envelope based on WTG capacity and as such it is not referred to within this Project Description.

4.3 Consultation and Commitments

4.3.1.1 Consultation is a key part of the application process. Consultation regarding the Project Description has been conducted through the Scoping Report (SBES, 2023) and stakeholder consultation. The final Design Envelope has been further refined where possible during the EIA process from that presented in the Scoping Report. Stakeholder comments received in the Scoping Opinion, during consultation meetings, and at public events have also been considered. An overview of the process is presented in **Volume ER.A.2, Chapter 5: Stakeholder Consultation.**

4.3.1.2 The Applicant has systematically identified impacts and effects, and taken into consideration primary and tertiary mitigation measures that may be adopted to reduce or eliminate environmental impacts.

4.3.1.3 The mitigation measures include both avoidance, best practice and design commitments, which are classified into primary, secondary or tertiary measures in accordance with the IEMA 'Guide to Shaping Quality Development' (2016) definitions. These commitments are included in **Volume ER.A.4, Annex 6.1: Commitments and Mitigations Register**. The Management Plans that the Salamander Project will be required to produce post-consent and be approved by the Scottish Ministers prior to construction will also help to mitigate potential impacts from the Offshore Development; these are presented in **Volume ER.A.2, Chapter 1: Introduction.**

4.3.1.4 A summary of the key issues raised during consultation specific to the Project Description are outlined in **Table 4-1**, together with how these issues have been considered in the production of this EIAR. Key comments in relation to project design and where they are addressed are also set out in **Table 4-1**.

Table 4-1 Consultation Responses

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
Marine Directorate – Licensing Operations Team (MD-LOT), on behalf of the Scottish Ministers	21 June 2023; Scoping Opinion	Section 4.4.1 of the Scoping Report states that the final layout of the windfarm components will be determined once the design optimisation process has been completed with a number of key sensitives to be considered. The Scottish Ministers advise that the EIA Report must include a full and detailed description of all layout options considered within the design envelope. The Scottish Ministers also advise that the Developer must identify how habitats of conservation value can be avoided through micrositing of windfarm components, inclusive of all cabling, in the EIA Report.	The final design and layout with up to seven turbines, of the Offshore Array has not been developed yet due to the need for prior decisions on technology (floating substructures, mooring and anchors and inter-array cables) to be made; these will be made post-consent, but layout options will be limited due to the limited number of turbines. However, the impact assessment considers a worst-case scenario for each impact, based on the Offshore Development Design Envelope. For many topics the detailed array layout is not required to undertake the assessments, but for those where a worst-case layout was required to be defined these have been described within the topic chapters (e.g. Aviation and Radar, Shipping and Navigation, Seascape and Landscape Visual Impact Assessment (SLVIA)). This allows for a full assessment and for representations by stakeholders to be made. The final layout and design will be developed through technical and commercial requirements and through consultation with relevant stakeholders and presented within the Development Specification and Layout Plan (DSLP), that will be subject to approval during the discharge of Section 36 consent and Marine Licence conditions. Identification of how habitats of conservation value can be avoided through micrositing of wind farm components, inclusive of all cabling is discussed within in **Volume ER.A.3, Chapter 9: Benthic and Intertidal Ecology**.

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
Marine Directorate – Licensing Operations Team (MD-LOT), on behalf of the Scottish Ministers	21 June 2023; Scoping Opinion	Section 4.4.2 of the Scoping Report states that two floating substructure designs are currently being considered for the Proposed Development. A design envelope has been provided in Table 4-2 of the Scoping Report. The Scottish Ministers advise that the EIA Report must include a full and detailed description of both floating substructure designs to be considered within the design envelope.	Details on the design of the floating substructures being considered within the design envelope is provided in Section 4.7.2.
	21 June 2023; Scoping Opinion	Section 4.4.3 of the Scoping Report details a number of anchor and mooring designs being considered. The Scoping Report states that the type and number of anchors and moorings required will be subject to refinement upon selection of the floating substructures. The EIA Report must provide details of the anchor and mooring design options being considered within the design envelope. In addition, if there is any potential for scour protection to be used, this must be assessed in the EIA Report including details on materials, quantities and locations.	Details on the anchor and mooring design options being considered within the design envelope is provided in Sections 4.7.3 and 4.7.4. Details on scour protection requirements is also provided in Sections 4.7.4 and 4.7.6. At this stage of the project design it is not possible to provide exact quantities or locations where scour protection may be needed, however worst-case quantities have been included within the design parameters tables which have then been used within each of the relevant impact assessments.
	21 June 2023; Scoping Opinion	Section 4.4.4 of the Scoping Report states that the Developer may choose the option to trench and/or bury portions of the inter-array cables and that the burial method and target burial depth will be defined based on a Cable Burial Risk Assessment. If there is any potential for cable protection to be used to protect the inter-array cables, this must be assessed in the EIA Report including details on materials, quantities and location. In addition, any seabed levelling or removal of substance or objects from on or under the seabed,	Details on the installation of the offshore cables (both inter-array and export) and requirements for seabed levelling and remedial cable protection are provided in Sections 4.7.5 and 4.7.8. At this stage of the project design it is not possible to provide exact quantities or locations where seabed levelling or additional rock protection may be needed, however worst-case quantities have been included within the design

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
Marine Directorate – Licensing Operations Team (MD-LOT), on behalf of the Scottish Ministers		required for installation of both the inter-array cables and export cables, will require consideration in the EIA Report and may require a marine licence.	parameters tables which have then been used within each of the relevant impact assessments.
	21 June 2023; Scoping Opinion	Section 4.5.2 of the Scoping Report details the inclusion of the EBI within the confines of the OnSS. The Scottish Ministers advise that the EIA Report must include a full and detailed description of the design parameters to be considered within the design envelope.	Details of the onshore infrastructure will be included in the Project Description within the Onshore EIAR, which will be submitted to Aberdeenshire Council and the Energy Consent Unit later in 2024.
	21 June 2023; Scoping Opinion	Section 4.6.5 of the Scoping Report states that the offshore export cables will make landfall north of Peterhead. With regard to methods of export cable installation, trenched or trench-less landfall techniques such as Horizontal Directional Drilling or similar is expected to be used. The EIA Report must describe and assess the options considered for cable installation at landfall and must also explain the reasons for the selected installation option(s). The EIA Report must clearly detail the landfall location and state the site-specific considerations. The EIA Report must also outline the steps taken to mitigate any environmental impacts resulting from the cable landfall. In addition, the Scottish Ministers advise that the EIA Report must include a full and detailed description of any scour protection and/or rock dumping that may be required including indicative locations and maximum quantities. The EIA Report must also clearly describe the export cable area including the width, length and location of export cable corridor.	The Salamander Project has taken the decision to remove trenched landfall solutions from the design envelope and has committed to using a trenchless solution between Mean Low Water Springs (MLWS) and the landward side of the foredunes. This decision and the subsequent environmental benefits are discussed in Section 3.4 of **Volume ER.A.2, Chapter 3: Site Selection and Consideration of Alternatives.** Details on the trenchless Landfall options being considered within the design envelope are provided in Section 4.8. It has not been possible for the Salamander Project to acquire project specific, or secondary survey data, within the nearshore ~8 km area of the Offshore Export Cable Corridor (ECC) (referred to as Nearshore ECC), in a timeframe suitable to undertake the EIA in 2023 for submission of the EIAR in early 2024. This current 'data gap' covers the area from the MLWS at the Landfall location, through to the 1°40 line approximately 8 km east; this seabed data was required to inform refinement of the Landfall location and so this process

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
Marine Directorate – Licensing Operations Team (MD-LOT), on behalf of the Scottish Ministers			has not been possible. Consequently, the Salamander Project has committed to acquiring this data in sufficient time to analyse, assess and report on any sensitive habitats and/or archaeological receptors that may be encountered in this section. Consultation with the relevant stakeholders will be undertaken on the results of this assessment, with a commitment to micro-routeing to avoid any sensitivities as far as technically possible. Further detail of these assessments is presented in **Volume ER.A.3, Chapter 9: Benthic and Intertidal Ecology** and **Volume ER.A.3, Chapter 17: Marine Archaeology and Cultural Heritage.** Details on the installation of the offshore cables (both inter-array and export) and requirements for seabed levelling and remedial cable protection are provided in Sections 4.7.5 and 4.7.8. At this stage of the project design it is not possible to provide exact quantities or locations where seabed levelling or additional rock protection may be needed, however worst-case quantities have been included within the design parameters tables which have then been used within each of the relevant impact assessments.
	21 June 2023; Scoping Opinion	Design Envelope The Scottish Ministers note the Developer's intention to apply a 'Design Envelope' approach. Where the details of the Proposed Development	This is noted; the worst-case design envelope for the Offshore Development is detailed within this chapter and assessed within all technical chapters.

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
Marine Directorate – Licensing Operations Team (MD-LOT), on behalf of the Scottish Ministers		cannot be defined precisely, the Developer will apply a worst-case scenario, as set out in 4.1 of the Scoping Report.	
	21 June 2023; Scoping Opinion	The Scottish Ministers advise that the Developer must make every attempt to narrow the range of options. Where flexibility in the design envelope is required, this must be defined within the EIA Report and the reasons for requiring such flexibility clearly stated. At the time of application, the parameters of the Proposed Development should not be so wide-ranging as to represent effectively different projects. To address any uncertainty, the EIA Report must consider the potential impacts associated with each of the different scenarios. The criteria for selecting the worst-case and the most likely scenario, together with the potential impacts arising from these, must also be described. The parameters of the Proposed Development must be clearly and consistently defined in the application for the s.36 consent and marine licences and the accompanying EIA Report.	This is noted; the worst-case design envelope for the Offshore Development is detailed within this chapter, and the relevant worst-case parameters presented and assessed within all technical chapters.
	21 June 2023; Scoping Opinion	The Scottish Ministers will determine the applications based on the worst-case scenario. The EIA will reduce the degree of design flexibility required and the submitted to the Scottish Ministers, for their approval, before works commence. Please note however, the information provided in Section 7 below regarding multi-stage consent and regulatory approval. The CMS will 'freeze' the design of the project and will be	Noted.

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
		reviewed by the Scottish Ministers to ensure that the worst-case scenario described in the EIA Report is not exceeded.	
	21 June 2023; Scoping Opinion	It is a matter for the Developer, in preparing the EIA Report, to consider whether it is possible to robustly assess a range of impacts resulting from a large number of undecided parameters. If the Proposed Development or any associated activities materially change prior to the submission of the EIA Report, the Developer may wish to consider requesting a new scoping opinion.	This is noted; the proposed Salamander Project has not changed materially since scoping to require a new scoping opinion.
Maritime and Coastguard Agency (MCA)	21 June 2023; Scoping Response	Attention should be paid to cabling routes and where appropriate burial depth for which a Burial Protection Index study should be completed and subject to the traffic volumes, an anchor penetration study may be necessary. If cable protection measures are required e.g., rock bags or concrete mattresses, the MCA would be willing to accept a 5% reduction in surrounding depths referenced to Chart Datum. This will be particularly relevant where depths are decreasing towards shore and potential impacts on navigable water increase, such as at the HDD location.	The Salamander Project commits to full Marine Guidance Note (MGN) 654 (MCA, 2021) compliance, including in relation to anchor studies and water depth reductions. A Cable Burial Risk Assessment (CBRA) will be undertaken post-consent.
MET Office	21 June 2023; Scoping Response	Met Office have concerns about <u>any</u> turbines which are located in line of sight and in the beam of the weather radar. However, it may be possible to mitigate against the potential risk of the turbines of this proposed scheme affecting the radar beam if, for example, the tip height of the	The Salamander Project notes this concern and has reduced the turbine parameters accordingly. The amended proposal is for WTGs with a maximum tip height of 310 m Ordnance Datum Newlyn (ODN). Details on the design envelope for the WTG are presented in Section 4.7.1.

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
		turbines was no greater than 310 m, rather than 325 m as per the current proposal.	
Ministry of Defence (MoD)	21 June 2023; Scoping Response	With regard to aviation safety, the requirement to install aviation safety lighting on the turbines proposed is set out in Table 9-9. The MOD would request that the development is fitted with MOD accredited aviation safety lighting in accordance with the Air Navigation Order 2016. The MOD will also require that sufficient information is submitted to ensure accurate marking of the development on aeronautical charts.	Appropriate lighting and marking of the Salamander WTGs will be established in consultation with the Civil Aviation Authority (CAA) and in accordance with CAA regulations and guidance (CAP 764; CAA Policy and Guidance on Wind Turbines (CAA, 2016). All required details of the Offshore Array will be provided to the MoD to enable accurate marking on aeronautical charts. Assessment of potential impacts on aviation safety is provided in **Volume ER.A.3, Chapter 15: Aviation and Radar.**
	21 June 2023; Scoping Response	The potential for unexploded ordnance (UXO) to be present within the study area and the necessity for clearance is acknowledged within Section 4.6.8 of the Scoping Report. The potential presence of UXO and disposal sites should be a consideration during the installation and decommissioning of turbines, cables, and any other infrastructure, or where other intrusive works are necessary	Details of the Salamander Project's approach to identifying potential UXO and dealing with them in a safe manner is provided in Section 4.7.8.
NatureScot	21 June 2023; Scoping Response	**Wet storage** Section 4.6.2 (Floating Substructures) refers to the potential for wet storage of the substructures prior to their installation within the array area, either at the initial assembly site, the wind turbine integration site or a separate dedicated storage location. Section 4.7.1 (Floating Assembly) also indicates that once operational the substructures and	Wet storage of the floating substructures (and integrated WTGs) prior to tow-out to site is considered to be outside the scope of this EIA and the Marine Licence applications for the Offshore Development. This is due to the fact that at this stage of the project it is not known which port(s) will be used for wet storage and therefore it is challenging to undertake a meaningful assessment of impacts related to wet storage. The intent is that the Salamander Project will utilise the services of a port(s) that offer

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
NatureScot		WTGs will form an integrated assembly piece – the replacement of any major component parts of which is expected to be achieved by towing the assembly to port. Wet storage could represent a significant impact. Consideration of the potential impacts on all receptors needs to be addressed with the EIAR and HRA. We would welcome further discussion on this as and when further details are confirmed, noting the intention to seek a separate marine licence application for any requirements for wet storage outwith the array area.	wet storage sites, which will have appropriate consents (obtained by the port authority) for wet storage of floating substructures, fabrication and assembly with the WTGs. To enable the availability of this option for the Salamander Project within the required timeframe, a partner of SWPC is an official member of the TS-FLOW UK-North Joint Industry Project (JIP)[2] exploring the challenges of wet storage and identifying the opportunities and potentially suitable locations for these activities. This JIP is in collaboration with relevant ports and other floating offshore wind developers. Separate Marine Licences and associated impact assessments for wet storage areas outwith the Offshore Development Area will be applied for and undertaken as appropriate.
	21 June 2023; Scoping Response	**Positive effects for biodiversity and nature inclusive design** We recommend both the consideration of positive effects for biodiversity as well as nature inclusive design aspects at this early stage and following through into the EIAR. Whilst not a current policy requirement, as part of our ability to address both the climate and biodiversity crises, we encourage developers to consider this as part of their application. As an Innovation Project we advise consideration of exploring innovations	The Salamander Project is planning a number of innovations that have potential environmental benefits. These are summarised below: <u>Marine Monitoring</u> Undertake a programme of marine monitoring throughout the lifetime of the Salamander Project, gathering data on seabed habitats and local biodiversity to help better understand how the structures and marine habitats interact.

[2] https://offshoresolutionsgroup.com/ts-flow-jip/

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
NatureScot		that benefit biodiversity, reduce environmental impact and contribute towards closing current knowledge gaps.	PREDICT A three-year research initiative led by experts at the University of Aberdeen and University of the Highlands and Islands' Environmental Research Institute. The work in PREDICT (Ørsted funded) is predicting the spatial differences for a range of main pelagic fish species (herring, mackerel, sprat and sandeel) cumulatively and across the seasons to help understand the total availability of fish to predators such as seabirds and marine mammals. Salamander provides opportunity to gather even more data extending PREDICT - will be the first to collect long-term (pre-installation) bottom-up data (plankton and physical factors) that may affect fish presence. Will be able to accurately represent before and after conditions in the water column and better understand windfarm effects on pelagic fish behaviour. SMEEF Salamander has contributed £50,000 to the Scottish Marine Environmental Enhancement Fund (SMEEF) to fund a mapping exercise which will identify opportunities for marine nature restoration in Scotland. Up to an additional £500,000 is also committed for piloting any recommended measures arising from this exercise which can fit in with the scope of the Salamander Project. The goal is to ensure that the

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
			surrounding marine environment and biodiversity are left in a better condition than they were prior to construction of the Salamander Project. <u>Net Zero Technology Centre (NZTC) – Innovation Network</u> Through the NZTC the various IN projects (Innovation projects part of the Innovation and Targeted Oil and Gas Decarbonisation (INTOG) leasing round) are collaborating on numerous projects, including one focused on reducing uncertainty in consenting by closing knowledge gaps in environmental and/or habitat information. <u>Low Carbon Materials</u> The Salamander Project is investigating the feasibility of low carbon materials for use in its foundations and how it can upscale these supply chains for future projects.
	21 June 2023; Scoping Response	As detailed in our advice above there is a lack of information on potential impacts of EMF from dynamic cables. Therefore, we encourage consideration of collaborating and contributing to monitoring of EMF impacts from dynamic cables as well as monitoring of entanglement with dynamic cables and mooring systems.	The Salamander Project has modelled the expected Electro-Magnetic Field (EMF) levels from the offshore export and inter-array cables, both dynamic and static; further details are provided in Section 4.9.6. Furthermore, Ørsted has commissioned a study into dynamic cable EMF (ERM, 2023), with the aims of:

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
NatureScot			- Reviewing publicly available EMF knowledge as it relates to marine high voltage (HV) cables; - Modelling the magnitude of EMF generated from a range of realistic floating offshore wind (FLOW) HV cable scenarios, including consideration of the installation conditions; and - Cross-correlating these two studies to determine the potential environmental impact on marine ecosystems from EMF generated by FLOW cable installations, and identify any topics that require future research. The study provides a robust foundation for the assessment of the potential impacts of EMF on marine receptors, notably fish and shellfish. The review of available literature on potential EMF impacts combined with modelling of EMFs generated from cables likely associated with the Salamander Project will allow the assessment of a realistic worst-case scenario based on the current knowledge base.
NatureScot	21 June 2023; Scoping Response	We also welcome that 'changes to coastal landfall morphology' has been identified and scoped in. However, the potential impacts of trenched landfall cable(s) being re-exposed by future coastal change should also be assessed. The likelihood of expanding and accelerating erosional retreat is highlighted in the Scoping Report (Section 7.1.5.8 and at Figure 7-6). If hard engineering/protection of re-exposed cable(s) may be required in	The Salamander Project has taken the decision to remove trenched landfall solutions from the design envelope and has committed to using a trenchless solution between MLWS and the landward side of the foredunes. This decision and the subsequent environmental benefits is discussed in Section 3.4 of **Volume ER.A.2, Chapter 3: Site Selection and Consideration of Alternatives.** One of the key consequences of this

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
		future, impacts on coastal morphology could arise. Therefore, this additional impact should be addressed either stand-alone or within the 'changes to coastal landfall morphology' impact. However, this may not be required if an embedded mitigation measure was included ensuring that re-exposed cable(s) would be appropriately re-buried without hard engineering/protection measures.	decision is that cables would not be exposed in the intertidal zone and so hard engineering/protection of re-exposed cable(s) will not be required.
Royal Yachting Association (RYA) Scotland	21 June 2023; Scoping Response	An additional risk is the failure of Aids to Navigation (AtNs) marking the devices. There have been several cases where lights or AIS transmissions have failed on wind farms off the coast of Scotland in recent months and it has taken several days to replace them due to adverse weather. Mitigation might include the use of virtual AtNs.	The Salamander Project will comply with the relevant IALA requirements including with regards to Aids to Navigation (AtoN) availability. Lighting and marking will be agreed with the Northern Lighthouse Board (NLB) post-consent, and a Lighting and Marking Plan (LMP) will be developed and submitted to MD-LOT for consultation and approval by the Scottish Ministers prior to the start of construction. Potential risks to navigation and shipping caused by the Offshore Development are assessed within **Volume ER.A.3, Chapter 14: Shipping and Navigation** and **Volume ER.A.4, Annex 14.1: Navigational Risk Assessment.**
Scottish Fishermen's Federation (SFF)	21 June 2023; Scoping Response	Page 18 of the report notes that "There is now no offshore substation planned as part of the Project, and that is therefore not considered further within the Scoping Report." In any case, if there are no offshore substations page 32 tell us that there will be subsea hub(s) and/or joint(s); therefore, they need to scoped.	Details of the subsea hubs and joints are provided in Sections 4.7.5 and 4.7.6. The worst-case design parameters for both have been included for assessment within the relevant topic chapters of the Offshore EIAR, including **Volume ER.A.3, Chapter 13: Commercial Fisheries.**

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
	21 June 2023; Scoping Response	SFF is content with the removal of obstacles such as UXO and discarded fishing gear to shore; however, in terms of boulders it is recommended that utmost effort should be made to not displace boulders. Displaced/relocated boulders creates snagging hazard for the fishing vessels and disturbs the marine environment. If displacement of boulders is the last resort for cable burial, it is recommended that the new location of the boulders is recorded and shared with SFF/fishing industry via USB flash sticks. In addition, if further large-scale boulders are identified during the survey work, SFF would like to know their location the same manner as the relocated boulders.	The requirement for, and extent of, boulder clearance and UXO clearance prior to installation of the seabed infrastructure will only be established during pre-construction surveys. The Salamander Project may be able to provide locations for picked and relocated boulders, however it is entirely dependent on the method/technology used for boulder removal. It is also noted that if locations are provided by the Salamander Project they are the locations of the boulders at the time of relocation and may subsequently move due to sea conditions. Further detail on these activities is provided in Section 4.7.8.
	21 June 2023; Scoping Response	P59, "4.8.1 Floating Assembly", indicates that where piled anchors have been used these would likely be cut approximately 1 m below the seabed, with due consideration made of likely changes in seabed level and only the upper section removed. At this point in time, it is not thought to be reasonably practicable to remove entire piles from the seabed, but endeavours will be made to ensure that the sections of pile that remain in the seabed are fully buried. Taking the nature of the seabed soil into account, SFF would hope to see them cut out as deep as possible and fully buried in to mitigate any possible scour and snagging hazard happening.	Piles, if utilised as the anchor solution, would likely be cut approximately 1 m below the seabed. At this point in time, it is not thought to be reasonably practicable to remove entire piles from the seabed, but endeavours will be made to ensure that the sections of pile that remain in the seabed are fully buried. The details of pile removal would be consulted on and agreed nearer the time of decommissioning, and any application would be supported by a comparative assessment process and a suitable body of evidence considering best practice and available technology at the time. Further details on the Salamander Project's decommissioning strategy are provided in Section 4.10.

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
Scottish Fishermen's Federation (SFF)	21 June 2023; Scoping Response	SFF is not content with leaving cable rock protection *in situ* and would prefer full removal of cable and rock where possible. However, SFF will be content with leaving the trenched and buried cable *in situ* if cable ends properly cut, sealed and securely buried. The SFF would reiterate the desire for clean seabed returned to as pre-development upon decommissioning, especially the rock protections. Furthermore, SFF expect the developer to commit/accept responsibility for the long-term monitoring of anything left in seabed post decommissioning to ensure safety of fishing vessels.	The Applicant is committed to restoring the Offshore Development Area to the condition that it was in prior to construction, as far as is reasonably practicable. A Decommissioning Programme will be submitted to MD-LOT for consultation and approval by the Scottish Ministers, a draft of which would be submitted prior to construction. The Decommissioning Programme will be updated during the Project's lifespan to take account of changing best practice and new technologies. The approach employed at decommissioning will be compliant with the legislation and policy requirements at the time of decommissioning. Further details on the Salamander Project's decommissioning strategy are provided in Section 4.10. In line with the details provided in this section, the Applicant is also committed to ensuring the Offshore Development is safely and effectively decommissioned.
	21 June 2023; Scoping Response	SFF will not be content with using concrete mattress on ECC protection in open sea. SFF want to see the scoping of the cables where they are not buried.	Where technically feasible, the Salamander Project will attempt to bury the offshore cables on the seabed. However, due to seabed conditions this may not be possible and some sections of the static cabling within both the Offshore Array Area and Offshore ECC may require additional remedial cable protection; this will be informed by the CBRA to be undertaken post-consent. Details of cable installation and additional remedial rock protection are provided in Section 4.7.5. Assessment of the potential impacts from cable installation has been undertaken in the relevant topic chapters of the Offshore EIAR, including **Volume ER.A.3, Chapter 13: Commercial Fisheries.**

Consultee	Date and Forum	Comment	Where it is addressed within this EIAR
	21 June 2023; Scoping Response	Considering the spatial footprint of floating substructure, SFF prefers TLP to be used instead of semi-submersible and barge. Given that the development cannot say which mooring and anchor system they choose all of them must be scoped in.	Both the semi-submersible and Tension Leg Platform (TLP) options for the floating substructures are included within the Project Design Envelope. Impacts of both floating substructure options are considered within **Section 13.11** of **Volume ER.A.3, Chapter 13: Commercial Fisheries**.

4.4 Salamander Project Location

4.4.1.1 The Salamander Project is split into several infrastructure locations, as delineated in **Figure 4-1,** and consists of the:

- **Offshore Array Area**: this is where the offshore wind generating station will be located, which will include the wind turbines, floating foundations and mooring system, subsea hub(s) and/or joint(s), and inter-array cables. At the boundary of the Offshore Array Area, array cables transition to the export cable(s).
- **Offshore Export Cable Corridor** (Offshore ECC): this is where the offshore export cable(s), will be located. The Offshore ECC runs from MHWS to the western boundary of the Offshore Array Area.
- **Intertidal Export Cable Corridor** (Intertidal ECC): this is the area between MLWS and MHWS where the export cable(s) will be installed.
- **Onshore Export Cable Corridor** (Onshore ECC): this is where Landfall occurs at the Transition Joint Bays (TJBs) and the onward onshore export cable(s) will be located. The Onshore ECC runs from the TJBs to the onshore substation.
- **Onshore Substation (OnSS)[3]:** comprising of the Salamander Project OnSS compound and the SSEN OnSS compound, and additionally the **Energy Balancing Infrastructure (EBI)**: this is where the energy balancing equipment will be located.

4.4.1.2 The onshore aspects down to MLWS will be addressed within the Onshore EIAR and are therefore outwith the scope of this EIAR and consents applications for the Offshore Development.

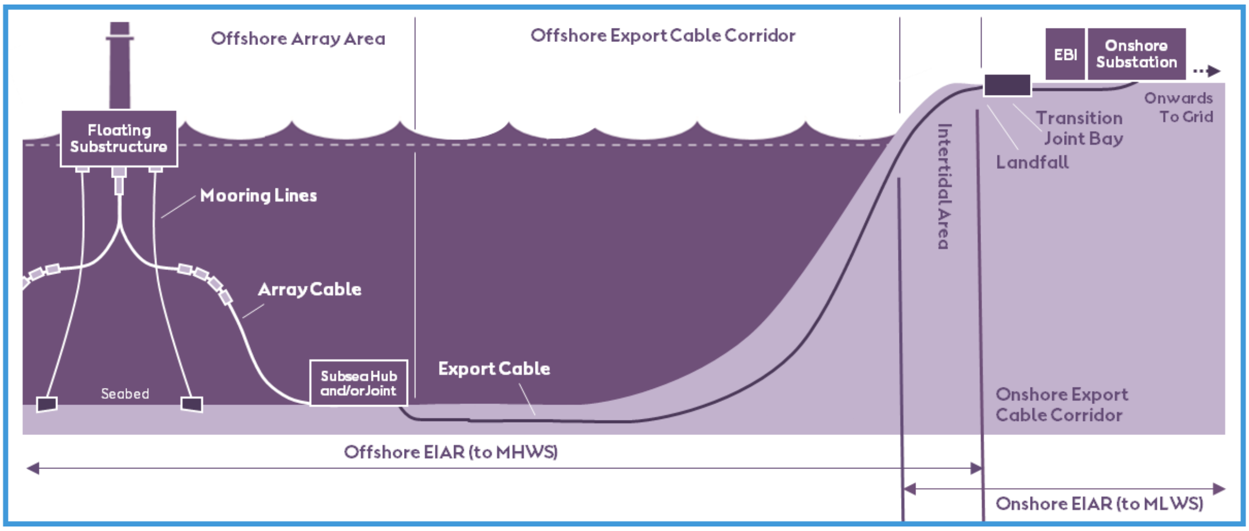


Figure 4-1 Salamander Infrastructure Locations

4.4.1.3 The physical boundaries of the Salamander Project's infrastructure locations are presented in **Figure 4-2.** The following sections of this Project Description describe the physical environment of these areas.

[3] The OnSS will be split into three compounds, one owned by the Salamander Project, one owned by SSEN where the physical connection to the onshore transmission system will be located. The third compound will be for the EBI infrastructure. The three compounds will be located adjacent to each other within the Onshore Development Area.

4.4.2 Offshore Array Area

4.4.2.1 The Offshore Array Area is approximately 35 km due east of Peterhead, at its closest. Water depths vary from around 86 m below Lowest Astronomical Tide (LAT) in the centre to around 102 m below LAT in the south-western corner. Sandwaves and ripples are present within the Offshore Array Area. Surficial sediments across the Offshore Array Area are typically sandy material with small amounts of gravel and muds.

4.4.3 Offshore Export Cable Corridor

4.4.3.1 Depths across the Offshore ECC are similar to the Offshore Array Area, with a maximum depth of 105 m below LAT in the southeastern part of the ECC where it meets the Offshore Array Area, and depths becoming shallower closer to the coastline. Sediments across the Offshore ECC show an increasing gravel content towards the coast, passing through areas of slightly gravelly sand, gravelly sand, and sandy gravel.

4.4.4 Intertidal Export Cable Corridor

4.4.4.1 The Intertidal ECC will be located within the Onshore and Offshore Development Areas where the offshore export cable(s) will cross from MLWS to MHWS. This area has moderate wave exposure and comprises mostly clean mobile sand and some areas of rocky and sedimentary habitats.

4.4.5 Onshore Export Cable Corridor

4.4.5.1 The Onshore ECC will be located within the wider Onshore Development Area which covers a mix of dunes, arable farmland and forestry, and shall be covered within the Onshore application.

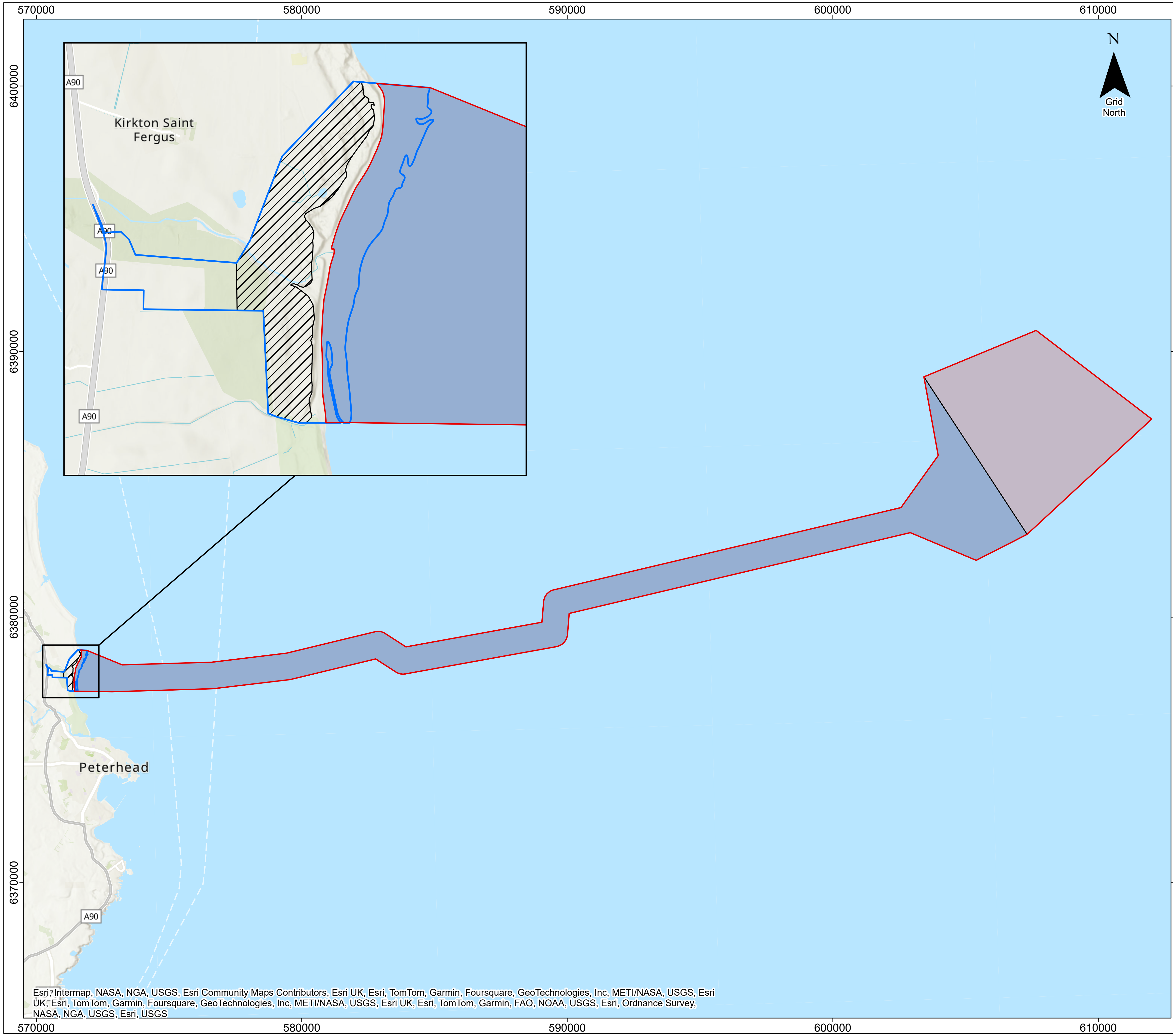
4.4.6 Onshore Substation including Energy Balancing Infrastructure

4.4.6.1 The OnSS and EBI including battery storage will be located in an area of arable farmland and forestry within 1.2 km to Landfall. This onshore infrastructure will include all necessary electrical equipment required to transform the power supplied from the wind farm to 132 kilovolt (kV) and to adjust the power quality and power factor, as required to meet the UK Grid Code for supply to the National Grid; this shall be described in more detail and assessed within the Onshore application.

4.5 Project Infrastructure Overview

4.5.1.1 The Salamander Project will have an installed capacity of up to 100 MW and comprise of wind turbines and all the infrastructure required to transmit the power generated by the turbines to the OnSS. The Salamander Project will also comprise any other infrastructure required to optimise and maintain the wind farm, such as EBI including battery storage, wave buoys and wind measurement devices. The onshore aspects above MLWS will be assessed within a separate Onshore EIAR and separate consent applications shall be submitted for the Salamander Project OnSS, associated infrastructure, EBI and the SSEN OnSS.

4.5.1.2 The Salamander Project will use High Voltage Alternating Current (HVAC) technology to bring the power to shore without the need for an offshore substation.



Salamander

Figure 4-2

Offshore and Onshore Project Boundaries for the Salamander Offshore Wind Farm

- Offshore Development Area
- Offshore Array Area
- Offshore Export Cable Corridor
- Indicative Onshore Development Area
- Landfall Compound Area of Search

Coordinate System: WGS 1984 UTM Zone 30N

Scale @ A3 : 1:140,000

0 2.5 5 Kilometers

0 0.75 1.5 3 Nautical Miles

Rev	Description	Date
00	Final Issue	16/04/2024
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Doc. Title : Offshore and Onshore Project Boundaries for the Salamander Offshore Wind Farm
Doc. No : SWF01OR0033
Created by : ES
Checked by : WG
Approved by : MM

4.5.1.3 The main offshore components will include:

- Up to seven offshore WTGs;
- Floating substructures to support the WTGs;
- Mooring and anchoring systems to connect the structures to the seabed;
- Inter-array cables (including both dynamic and static cable sections) to collect the power from the WTGs;
- Connection hub(s)/joint(s) on the seabed, and their associated foundations; and
- Up to two static export cable(s) either from the connection hubs or as a continuation of the dynamic inter-array cables to bring power ashore.

4.5.1.4 At Landfall, the offshore export cable(s) will be joined to onshore export cables at the TJB(s) which will be located above MHWS. The main onshore components will include:

- TJB(s) to join the offshore and onshore cables;
- Onshore export cables buried in up to two trenches (if required)[4];
- OnSS and EBI compounds and associated infrastructure;
- Grid connection works; and
- An access road to the OnSS and EBI.

4.5.1.5 The Salamander Project will include EBI alongside the OnSS to provide services to the whole energy system, which may include importing, storing and exporting energy to meet grid needs, improving grid stability and reliability, or providing additional services such as system monitoring and computing.

4.5.1.6 **Table 4-2** lists the key components of the Salamander Project and the links within this chapter to their descriptions.

Table 4-2 Main Components of the Salamander Project

Component	Number / Length / Area	Section
Wind Turbine Generators	≤ 7	4.7.1
Floating Substructures	≤ 7	4.7.2
Mooring Lines	≤ 56	4.7.3
Anchors	≤ 56	4.7.4
Offshore Cables (Total Combined Length)	≤ 85 km	4.7.5
Subsea Hubs	≤ 2	4.7.6

4.6 Project Construction Programme

4.6.1.1 An indicative construction programme covering installation of the Salamander Project's major components is presented in **Figure 4-3**. The programme illustrates the likely periods during which major installation

[4] It may be that the landfall compound is close to the OnSS, and consequently the landfall works may be designed in such a way as to allow the offshore export cable(s) to be pulled directly into the OnSS, in which case no onshore export cables would be required.

elements are undertaken, and how they may relate to one another in the construction campaign. The durations in **Figure 4-3** are intended to show the periods during which various activities may take place, rather than the precise duration of any specific activities.

4.6.1.2 Prior to the start of construction, post-consent, the Salamander Project will conduct a range of offshore survey activities, to collect the required data to inform the design of the infrastructure and ensure the safety of the construction activities. Other surveys may also take place throughout the construction period.

4.6.1.3 In preparation for construction, a range of additional supporting activities may take place, including further offshore surveys, demarcation of the Offshore Array Area and installation of buoys offshore. Seabed preparation activities will also take place such as seabed clearance, sandwave levelling and boulder clearance; further details are provided in **Section 4.7.8**.

4.6.1.4 Unexploded Ordnance (UXO) clearance may also be required if UXO are found in the Offshore Development Area; further assessment will be undertaken as part of an application for a separate Marine Licence for UXO clearance and so this activity does not form part of this Marine Licence application.

4.6.1.5 For the purpose of this EIA “commencement of construction activities”, means those works seaward of MHWS, which are the first of any licensed marine activities authorised by the Section 36 and Marine Licences, except for operations consisting of pre-construction surveys and monitoring approved under the Section 36 and Marine Licences.

4.6.1.6 The earliest possible date that onshore construction could commence is January 2027 and the expected start of offshore construction to be a year later in Q2 of 2028. The maximum total construction duration (onshore and offshore) is three years (36 months), and the maximum total duration anticipated for offshore construction (including cable landfall works) is 18 months. The Offshore Array is anticipated to be commissioned and operational by Q4 2029.

4.6.1.7 It is anticipated that the landfall works and the installation of the moorings and anchors will be undertaken in the first year of offshore construction, with the WTGs being connected to the mooring systems and inter-array cables and then commissioned in the second year of offshore construction. The offshore export cables and inter-array cables may be installed in either the first or second year of offshore construction. These expected construction periods are shown in **Figure 4-3** as well as alternative periods (i.e. the alternate year) depending on the final sequencing of construction activities. These alternative periods also provide potential extended construction periods if there are any delays in the installation programme due to weather or other unforeseen circumstances.

4.6.1.8 The nature of offshore work requires operations to be planned on a 24-hour, seven days a week basis; however, work will not be continuous over the whole construction period. The durations presented **Figure 4-3** are indicative only and may be subject to change as a result of issues such as poor weather and/or site conditions, delays with equipment lead times, sequential work requirements, and other logistical issues.

4.6.1.9 A final detailed construction programme for the Offshore Development will be developed during the detailed design phase post-consent once the design of the wind farm and procurement activities are more advanced. Should consent be granted, full details of the construction programme, construction sequencing and installation methodologies will be confirmed within the Construction Programme and Construction Method Statement (CMS) for the Offshore Development, and this will be submitted to MD-LOT for approval on behalf of Scottish Ministers prior to the start of construction.

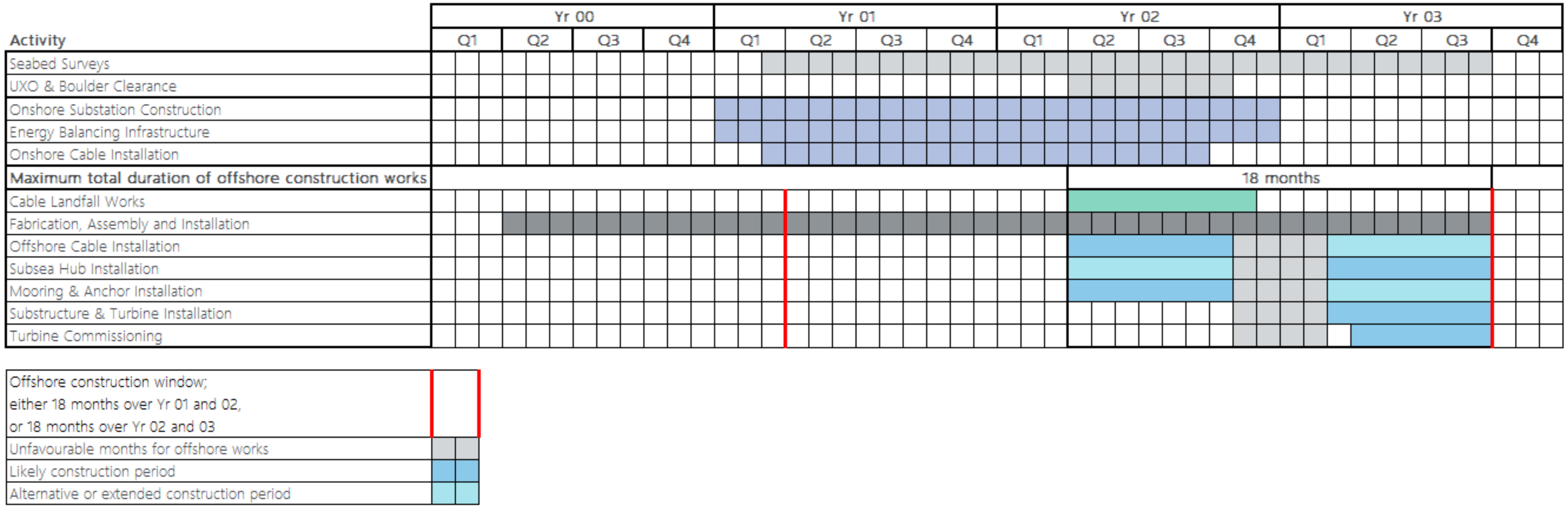


Figure 4-3 Indicative Construction Programme

(showing the windows within which Construction Activities may take place (noting durations of individual activities are likely to be shorter than the windows themselves, and that the programme is subject to change and will be confirmed in the Construction Programme)

4.7 Offshore Infrastructure

4.7.1 Wind Turbines

4.7.1.1 The Salamander Project may construct up to seven WTGs. A range of WTG models will be considered, and the final model of WTG may be selected post-consent. The worst-case design scenario for the WTGs is shown in **Table 4-3**. An illustrative WTG is shown in **Figure 4-4** which serves to define the parameters of the WTG envelope.

4.7.1.2 Due to the specific characteristics of WTGs based on floating substructures (see Section 4.7.2), the heights in **Table 4-3**, and throughout this document, are defined with respect to different reference sea levels for different foundation types. For semi-submersible foundations, which can move with the water level, heights are defined with respect to Still Water Level (SWL), the average water surface elevation at any instant, excluding local variations due to waves, but including the effects of tides and storm surges. For tension leg platforms (TLP), which do not move noticeably with the water level, heights are defined with respect to LAT.

Table 4-3 Worst-case Design Scenario – Wind Turbines

Component	Design Envelope
Number of Wind Turbine Generators	≤ 7
Rotor Blade Diameter	≤ 250 m
Total Rotor Swept Area	≤ 343,612 m^2
Height of Lowest Blade Tip (SWL for semi-sub and LAT for TLP)	≥ 22 m
Height of Highest Blade Tip (ODN)	≤ 310 m
Hub Height (SWL)	≤ 172.5 m
Spacing between Turbines (from centre point of WTG tower)	≥ 1,000 m

Design

4.7.1.3 The WTGs convert wind energy to electricity and consist of rotor blades, a tower, gearboxes, transformers, power electronics and control equipment. All options will follow the traditional WTG design with three blades and a horizontal rotor axis. The blades will be connected to a central hub, forming a rotor which turns a shaft connected to the generator or gearbox (if required). The generator and gearbox will be located within a containing structure known as the nacelle situated adjacent to the rotor hub. The nacelle will be supported by a tower structure affixed to a transition piece or directly to the foundation.

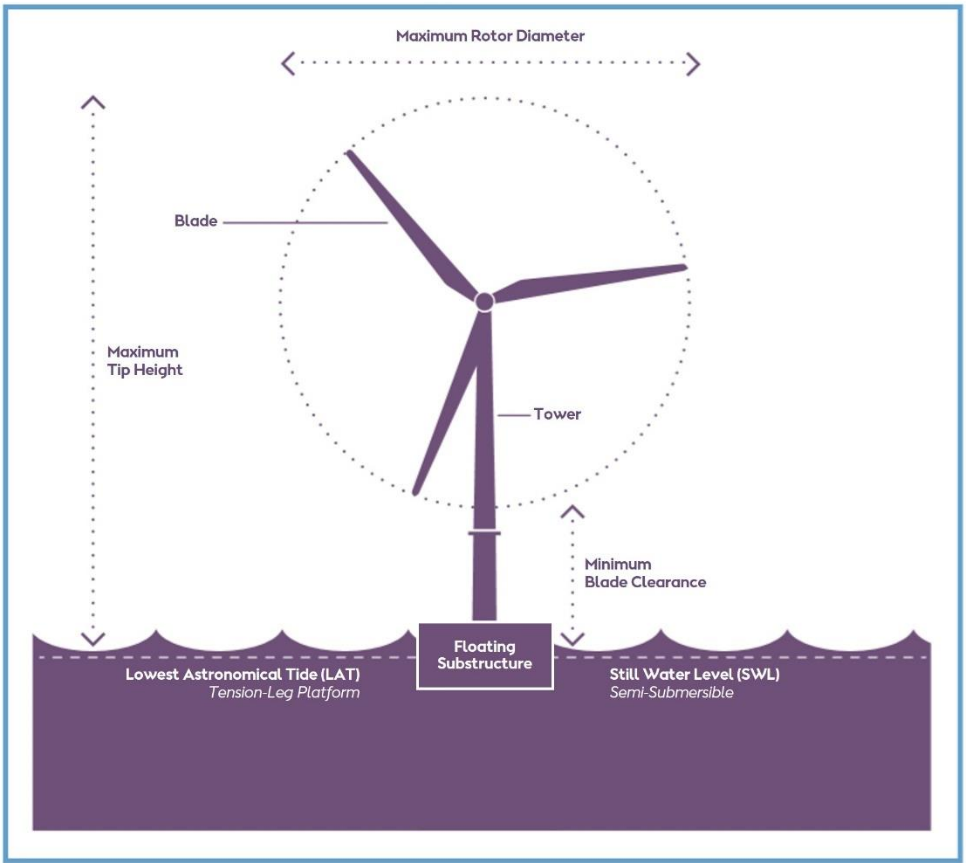


Figure 4-4 Indicative Floating Wind Turbine Generator.

Access

4.7.1.4 Personnel access and egress of the foundations and WTGs may be either from a vessel via a boat landing or a stabilised gangway via the foundation or transition piece, or by an active heave compensated hoist on the foundation, or by hoisting from a helicopter to a heli-hoist platform on the nacelle. Any helicopter access would be designed in accordance with relevant CAA guidance and standards.

Layout

4.7.1.5 The layout of WTGs within the Offshore Array Area will be determined once the design optimisation process has been completed and will need to balance a number of key sensitivities including WTG type, prevailing wind directions, geophysical characteristics, metocean conditions, benthic habitats, the specific floating substructure and anchor design chosen and navigational safety considerations. The Salamander Project requires flexibility in the location of the WTGs to ensure that anticipated changes in available technology and project economics can be accommodated within the Project Design Envelope. The final design layout will be determined post-consent and set out within the Design Specification and Layout Plan (DSLP).

4.7.1.6 The minimum spacing between WTGs is 1,000 m from the centre point of the WTGs for all development scenarios. For those receptors that required a worst-case layout to be defined in order to undertake the impact assessments, these have been described within the relevant topic chapters (e.g. Aviation and Radar, Shipping and Navigation, SLVIA).

Oils and Fluids

4.7.1.7 Each WTG will contain components that require lubricating oils, hydraulic oils, and coolants for operation. The maximum requirements for oils and fluids in a single WTG (not including any other infrastructure sited on the floating substructures) are shown in **Table 4-4**.

Table 4-4 Worst-case Design Scenario – Oil and Fluids in a Single Wind Turbine

Component	Design Envelope
Grease	≤ 1,300 l
Hydraulic Oil	≤ 20,000 l
Gear Oil	≤ 2,000 l
Silicon / Ester Oil	≤ 7,000 l
Diesel Fuel	≤ 2,000 l
Nitrogen	≤ 80,000 l
Glycol / Coolants	≤ 13,000 l
SF6 (sulphur hexafluoride)	≤ 6 kg

Installation

4.7.1.8 The exact methodology for the assembly is dependent on WTG type and installation contractor, as well as on the choice and location of ports and fabrication yards, and will be defined during the pre-construction phase after grant of consent. The WTGs may be installed upon their respective foundations either:

- Directly within the Offshore Array Area using a heavy-lift vessel; or
- In port using a quayside crane, or similar, prior to the combined foundation and WTG being transported to the Offshore Array Area.

4.7.1.9 When performing WTG assembly within the Offshore Array Area, the installation vessel will pick up the required components from a port. This vessel will then transit to the Offshore Array Area, and the components will be lifted onto an existing pre-installed floating substructure by the crane on the installation vessel. WTG components may also be loaded onto barges or dedicated transport vessels for transport to the site prior to installation by the heavy lift vessel.

4.7.1.10 When performing WTG assembly in port, a quayside crane or in-harbour crane vessel will be used to lift components from the quayside onto the floating substructure, which will have been floated out and either moored or grounded in port prior to WTG installation. Ballasting and de-ballasting of the floating substructure may take place in harbour as part of this installation process. A towing spread consisting of tugs and anchor handling vessels will then transport the combined foundation and WTG to the Offshore Array Area.

4.7.1.11 Installation vessels may be assisted by a range of offshore construction, support, and transport vessels. These are typically smaller vessels that may be tugs, guard vessels, anchor handling vessels, or similar. These vessels will primarily make the same movements to, from and around, the Offshore Array Area as the installation vessels they are supporting.

4.7.1.12 For the purposes of the EIA, assumptions have been made on the maximum number of vessels and helicopters and the number of return trips to the Offshore Array Area from port/airfield that are required throughout construction. Details of these vessel movements are set out in **Table 4-16.**

Control Systems

4.7.1.13 A Supervisory Control and Data Acquisition (SCADA) computer system monitors and controls the output from each wind turbine. The nacelle will be able to rotate or 'yaw' on the vertical axis in order to face the oncoming wind direction and the rotor blades can pitch; the blades rotate into or out of the wind to control the rotational speed and generator torque.

4.7.1.14 The WTGs start to generate power when the wind speed reaches an average of about 3 to 5 m/s. The output increases with the wind speed until the wind speed reaches the rated wind speed, which is typically about 10 to 13 m/s; beyond this point, the output is regulated at rated (maximum) power. When the maximum operational wind speed is reached, typically 25 to 35 m/s, the WTG will cut-out, either fully or gradually, in order to limit loading. If the high wind speed cut-out is gradual, the WTG will continue to generate some power through to higher wind speeds, the maximum being dependent on the wind turbine design.

4.7.2 Floating Substructures

4.7.2.1 The Salamander Project's WTG will be installed on floating substructures. These will be either Semi-Submersible (barge / buoy / hybrid) or TLP structures shown schematically in **Figure 4-5**. As described in the Scoping Report, conventional spar structures are not included in the Project Design Envelope as they are not compatible with the water depths in the Offshore Array Area with the Salamander Project's intended WTG design envelope. The worst-case design scenarios for the floating substructures are shown in **Table 4-5**.

4.7.2.2 The specific technology and make-up of the floating substructures has not yet been selected. The technical feasibility of the different foundation types is currently being considered via the development of ground and structural models, which are informed by the acquisition of survey data. Consequently, the final decision on foundation design will be made post-consent and be set out within the Design Statement (DS), but will remain within the values of the Design Envelope.

4.7.2.3 Floating substructure technology is constantly evolving, and new and innovative concepts may emerge during development of the project. As befits its nature as an innovation project, the Salamander Project may also choose to use novel floating substructure concepts such as barge, buoy or hybrid designs, collectively referred to as Semi-Submersible (SS).

4.7.2.4 Since submission of the EIA Scoping Report (SBES, 2023), the Salamander Project has further explored variations of the semi-submersible concept, such as barge, buoy, or hybrid. The visual appearance of the concepts varies. For example, by the number of columns present or absence of any columns, or by the relative draft, as illustrated indicatively in **Figure 4-5**. However, they are all buoyancy-stabilised platforms that float and are partially submerged. Any such solution would fit within the definition of semi-submersible below, and the worst-case design scenarios set out in **Table 4-5**.

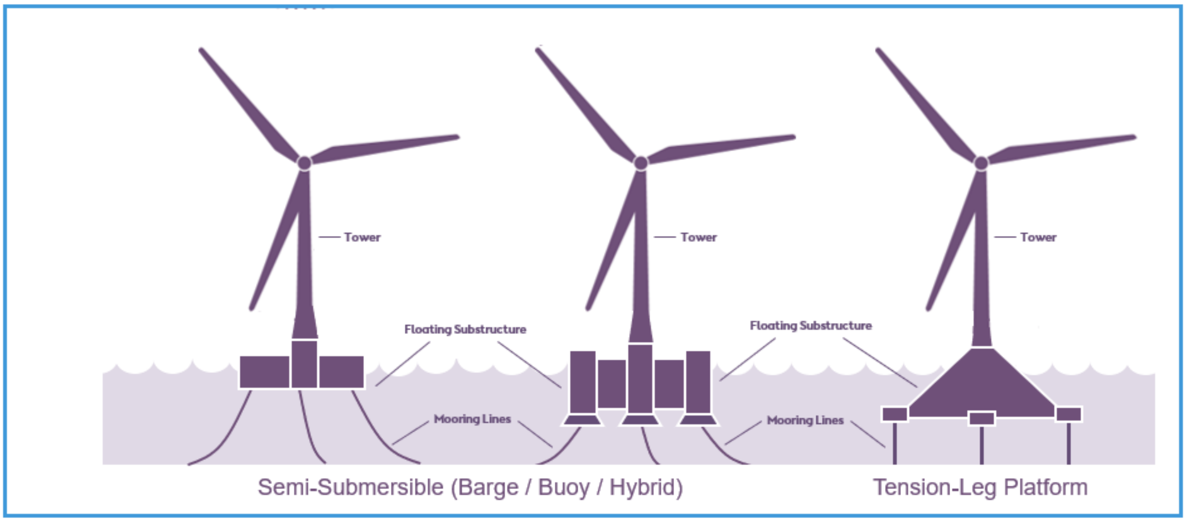


Figure 4-5 Indicative Floating Substructure Configurations

Table 4-5 Worst-case Design Scenario – Floating Substructures

Component	Semi-Submersible (including barge / buoy / hybrid)	Tension Leg Platform
Number of Turbines per Floating Substructure	1	1
Structure Length / Width	≤ 140 m	≤ 125 m
Sea Surface Footprint (per Structure)	≤ 19,600 m^2	≤ 15,625 m^2
Total Area of Sea Surface occupied by Structures	≤ 137,200 m^2	≤ 109,375 m^2
Height above Water	≤ 25 m	≤ 25 m
Draught Range during Integration and Towing	5 – 20 m	5 – 20 m
Draught Range during Operation	10 – 24 m	15 – 40 m

Semi-Submersible

4.7.2.5 The SS structure is a buoyancy-stabilised platform which floats partially submerged on the surface of the ocean whilst anchored to the seabed. The structure gains its stability through the distribution of buoyancy force associated with its large footprint and geometry which ensures the wind loading on the structure and turbine are countered by an equivalent buoyancy force on the opposite side of the structure.

Tension Leg Platform

4.7.2.6 The TLP is a semi-submerged buoyant structure, anchored to the seabed with tensioned mooring lines. The combination of the structure buoyancy and tension in the anchor/mooring system provides the platform stability. This system-driven stability (as opposed to the stability coming just from the floating substructure itself) allows for a comparatively smaller and lighter structure compared to SS equivalents.

Design

4.7.2.7 The floating substructures can take on a range of different shapes, dictated by the specific requirements of their specific design, this includes, but is not limited to, triangular, square, star-shaped and 'flower'-shaped, as shown in **Figure 4-6**. The WTG tower and any support columns may be mounted anywhere on the structure, determined primarily by stability and maintenance requirements.

4.7.2.8 The primary structure of the floating substructure will be manufactured from either steel, concrete, or a combination of the two.

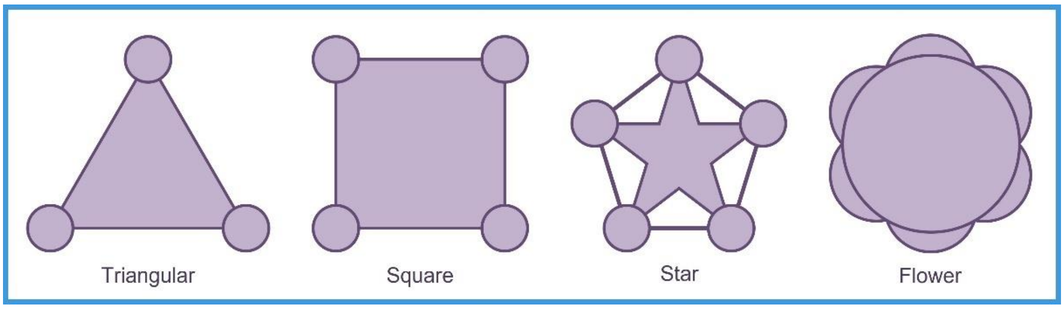


Figure 4-6 Top-Down View of Indicative Floating Substructure Shapes

4.7.2.9 The floating substructures may include boat landing features, ladders, a crane, and other ancillary components (such as radar or other monitoring equipment) as well as a flange for connection to the WTG tower. The floating substructures may also be equipped with a diesel generator for commissioning of the WTGs.

4.7.2.10 The floating substructure may contain passive ballast to ensure stability, as well as active ballast systems which can move air and/or water into and out of the structure to adapt the buoyancy of the structure. This serves to maintain the vertical alignment of the WTG tower, both during towing, installation, and operation

4.7.2.11 The Salamander Project will deploy a range of sensors for monitoring the floating structures. This will include the use of a position monitoring system to enable the precise location of each floating substructure to be known at all times, as well as equipment to detect any failure of the mooring systems (see **Section 4.7.3**).

4.7.2.12 The floating substructures will be painted yellow where relevant above the waterline and marked as per relevant regulatory guidance. The positions of the structures will be conveyed to the UK Hydrographic Office (UKHO) so that they can be incorporated into Admiralty Charts and the Notice to Mariners (NtM) procedures.

Corrosion Protection

4.7.2.13 To protect the floating substructures against corrosion, the structures may be coated and / or equipped with impressed current cathodic protection and / or sacrificial anodes. Anodes are fastened to an internal or external structure and corrode away preferentially thereby preventing the corrosion of the primary structure. The Salamander Project will use anodes made of aluminium, zinc or magnesium alloys with only small quantities of other metals.

Installation

4.7.2.14 The floating substructures will be fabricated offsite, and be assembled at quayside either onshore, in dry-dock, a floating dry-dock or on a semi-submersible barge. Once complete, the structures are 'floated-out' or 'deployed' (i.e. placed into the water or skidded via a slipway) in preparation for installation within the Offshore Array Area.

4.7.2.15 The completed floating substructures, either with or without a pre-installed wind turbine, are then towed by sea to the Offshore Array Area. Upon arrival, the structure will be manoeuvred into position. Vessels such as tugboats, anchor handling vessels, offshore constructure vessels or similar, will be used to steer the structure into the correct position and orientation. Anchors, moorings and / or array cables may have been pre-installed ahead of floating substructure installation, in which case the structure is hooked-up and connected to these components. If this is not the case, anchor, mooring and / or array cable installation and connection may take place immediately prior to, or in parallel with, foundation installation. Details of vessel movements are set out in **Table 4-16**.

4.7.2.16 Depending on the location of the assembly site, the floating substructures may be towed by sea to a different site for integration of the wind turbine and/or additional structural work prior to installation of the combined structure within the Offshore Array Area.

4.7.2.17 Additionally, there may be a need for wet storage of the substructures prior to installation, either at the initial fabrication or assembly site, the wind turbine integration site or a separate dedicated storage location. If the need for a separate wet storage location is confirmed, the intent is that the Salamander Project will utilise the services of a port(s) that offer wet storage sites, which will have appropriate consents (obtained by the port authority) for wet storage of floating substructures, fabrication and assembly with the WTGs. Separate Marine Licences and associated impact assessments for wet storage areas outwith the Offshore Development Area will be applied for and undertaken as appropriate.

4.7.2.18 The floating assembly may require touch up painting during construction and commissioning in order to remain in compliance with marking regulations and maintain the integrity of the asset.

4.7.3 Mooring Systems

4.7.3.1 The mooring system is responsible for the station-keeping of the floating substructures and needs to maintain the position of the WTGs even during the most extreme events or energetic storms.

4.7.3.2 The Salamander Project may use between three and eight mooring lines attached to each floating substructure. A minimum of three mooring lines are required in order to hold the structure in position, while additional mooring lines maybe be required either due to the specifics of the floating substructure design, or to add redundancy in case of failure. The mooring lines are laid out in multiple directions holding the platform stable.

4.7.3.3 The Salamander Project may use either catenary, semi-taut, taut or tension moorings, depending on the specifics of the chosen floating substructure, anchor type and the seabed and metocean conditions onsite. These mooring configurations are provided in **Figure 4-7**. The worst-case design scenarios for the mooring systems are detailed in **Table 4-6**.

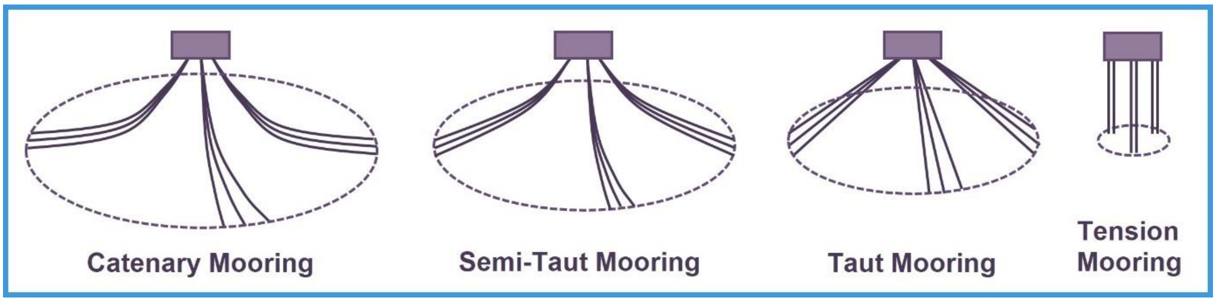


Figure 4-7 Indicative Mooring System Configurations

Catenary Mooring

4.7.3.4 A catenary mooring consists of metal chains and/or wires and in some cases synthetic fibre elements whose weight and curved shape holds the floating substructure in place. The lower section of the mooring system rests on the seafloor and provides restoring forces through the suspended weight of the mooring lines. The mooring line terminates at the seabed horizontally and the anchor point is only subjected to horizontal loads.

Semi-Taut Mooring

4.7.3.5 A semi-taut mooring consists of a combination of metal chain and / or wire and synthetic fibre elements, with the weight of the metal sections providing the restoring forces while the synthetic fibre sections, which are placed under some tension, limit the amount of metal required. This reduces the footprint of the mooring system compared to a pure catenary system but requires the use of anchors capable of handling some vertical loads.

Taut Mooring

4.7.3.6 A taut mooring consists of synthetic fibres, which use their elasticity, the buoyancy of the floating substructure and a firm anchor to maintain high tension in the mooring lines and thereby ensure stability of the structure. Taut mooring lines require tensioning and may terminate at an angle to the seabed, requiring the transfer of both horizontal and vertical loads to the anchors.

Tension Mooring

4.7.3.7 Tension mooring is specific to TLP structures and may consists of metal wire, metal tendons and / or synthetic fibre elements arranged in a vertical, or near vertical, configuration under significant tension (against the upward buoyancy of the floating substructure). This provides a compact footprint and a stable platform for the WTGs but puts significant loads on the anchors which need to be specifically designed to handle the higher loads.

Table 4-6 Worst-case Design Scenario – Mooring Systems

Component	Catenary	Semi-Taut	Taut	Tension
Number of Mooring Lines per Floating Substructure	3 – 8	3 – 8	3 – 8	3 – 8
Total Number of Mooring Lines	≤ 56	≤ 56	≤ 56	≤ 56
Mooring Line Radius	≤ 1,500 m	≤ 1,500 m	≤ 1,500 m	≤ 125 m
Mooring Line Length (per Mooring Line)	≤ 1,650 m	≤ 1,650 m	≤ 1,650 m	≤ 150 m
Mooring Line Diameter (Wire / Rope / Cable)	≤ 300 mm	≤ 300 mm	≤ 300 mm	≤ 300 mm
Mooring Line Bar Diameter (Chain)	≤ 210 mm	≤ 210 mm	-	-
Contact Length with Seabed (per Mooring Line)	≤ 1,000 m	≤ 800 m	0 m	0 m
Excursion Radius of Floating Substructures	≤ 70 m	≤ 70 m	≤ 50 m	≤ 50 m
Total Area of Seabed swept by Mooring Lines	≤ 3,920,000 m^2	≤ 3,136,000 m^2	0 m^2	0 m^2
Number of Mooring Clumps per Mooring Line	≤ 10	≤ 10	0	0
Dimensions of Individual Mooring Clumps	≤ 2.5 x 2.5 x 2.5 m	≤ 2.5 x 2.5 x 2.5 m	-	-

Design

4.7.3.8 A complete mooring system, as shown in **Figure 4-8**, consists of the mooring lines, their anchors as described in **Section 4.7.4**, as well as various connectors and ancillary components that may be connected to the mooring system to adjust its behaviour. These may include, but are not limited to, clump weights, buoys / buoyancy elements, load reduction devices and / or tensioners.

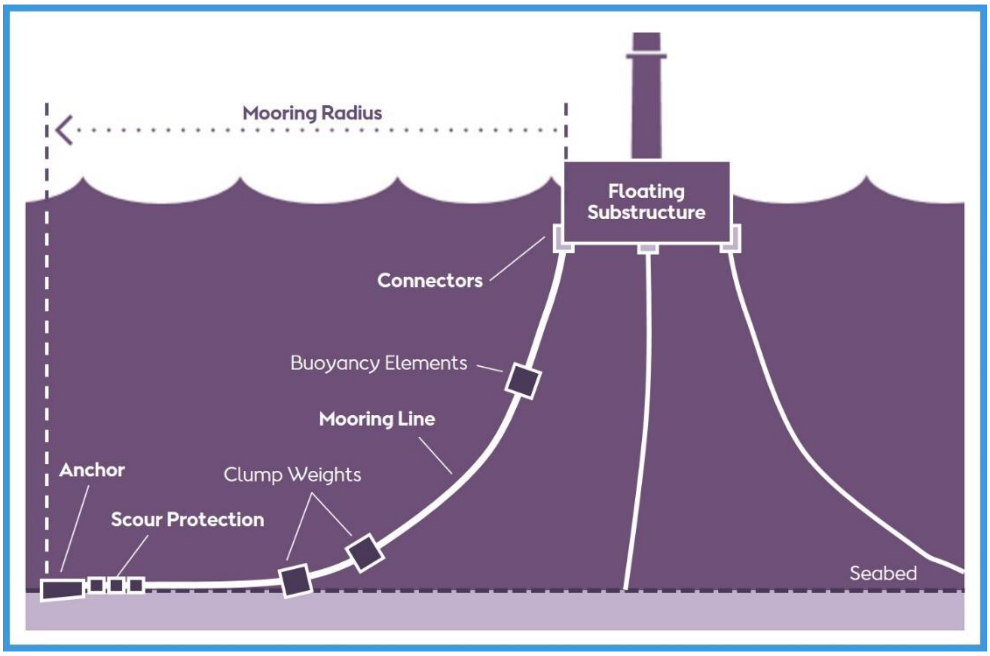


Figure 4-8 Components of the Mooring System

4.7.3.9 The mooring lines may comprise one or more of the following solutions, metal chains, metal wire ropes / cables, metal tendons / tubulars and synthetic fibre ropes.

4.7.3.10 The point of connection between the mooring lines and the floating substructures is dependent on both the type of mooring system and the type of floating substructure. The connection point may be anywhere from the bottom to the top of the substructure.

4.7.3.11 Clump weights and /or buoyancy modules may be used with either catenary or semi-taut mooring systems in order to add mass to the mooring line and / or dampen the lateral movement of the floating substructure. This allows the line tension to be optimised along the mooring line. The clump weights may comprise one or more of the following materials: cast iron, reinforced concrete and / or sand, and they may be situated on the mooring line either in contact with the seabed or suspended within the water column.

Excursion

4.7.3.12 Inherent to the use of WTGs on moored floating substructures is the fact that the structures will exhibit a degree of lateral motion depending on the wind, wave and current conditions, as well as the type and design of the floating substructures and their mooring.

4.7.3.13 The coordinates of the WTGs and their floating structures in the DSLP will refer to the location of the centre-point of the WTG tower in calm conditions. The floating substructures and their mooring will be installed such that the tower centre-point aligns with these coordinates when the sea is calm and the wind is still.

4.7.3.14 Under normal operation the locations of the floating substructures may experience some lateral movement caused by environmental forces. This lateral excursion will be the result of short-term effects, such as wave and wind gusts, and long-term effects, such as tidal currents and wind direction. The maximum excursion, when all factors act in the same direction, will stay within the maximum excursion radii set out in **Table 4-6** and illustrated in **Figure 4-9**.

4.7.3.15 From a navigational point of view, the position of the foundation can be expected not to change significantly as it is approached and passed.

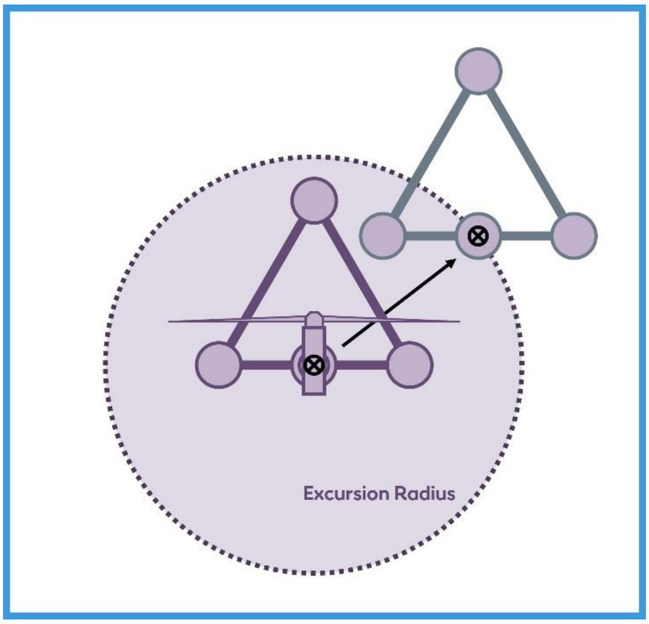


Figure 4-9 Floating Substructure Excursion

4.7.3.16 The mooring lines may need to be periodically re-tensioned during the lifetime of the wind farm due to stretching and / or anchor creep. In between these periods, the neutral position of the floating substructure may drift slightly from the documented position, but in all cases the total movement will not exceed the maximum excursion radii set out in **Table 4-6**.

4.7.3.17 In the event of a mooring line failure, the lateral excursion of the structure may temporarily exceed the stated limits until the problem is rectified. The floating substructures will be continuously monitored in order to be able to rapidly detect such an event.

Installation

4.7.3.18 The approach taken to the installation of the mooring lines will be heavily dependent on the type of anchors used, and their associated installation methods, see **Section 4.7.4**. A typical installation sequence will either be simultaneous installation of the anchors and their mooring lines, or anchor installation prior to mooring installation, with the moorings then hooked up to these pre-installed anchors.

4.7.3.19 To ensure efficient installation, the mooring system is usually installed and wet-stored near their permanent position in the Offshore Array Area prior to the arrival of the floating assembly. Wet-storage of mooring systems involves the mooring lines being laid on the seabed ahead of being connected to the floating substructure. Alternatively, where some or all portions of the mooring lines are required to be out of contact with the seabed during wet-storage, permanent or temporary buoyancy aides may be used to ensure this with clump weights used to ensure stability.

4.7.4 Anchors

4.7.4.1 The end of each mooring line connects to an anchor, as shown in **Figure 4-8**. As a result, the Salamander Project may use up to eight anchors for each floating substructure.

4.7.4.2 Depending on the chosen mooring concept and layout of the infrastructure, individual anchors may be connected to one or more mooring lines, such that multiple mooring lines may share a single anchor. For certain layout configurations, mooring lines from different floating substructures may also be connected to a common anchor, resulting in sharing of anchors between structures.

4.7.4.3 There are a number of anchoring solutions available, depending on the type of mooring system, seabed condition, and the required holding capacity. The Salamander Project may use one or a combination of the following anchor types: drag-embedment anchors, vertical load anchors (also referred to as plate anchors), piles (including standard impact or vibro-hammer installed piles, helical piles and / or drilled piles or micro-piles), suction caissons or gravity anchors, as shown in **Figure 4-10**. The worst-case design scenarios for the different anchors are shown in **Table 4-7**.

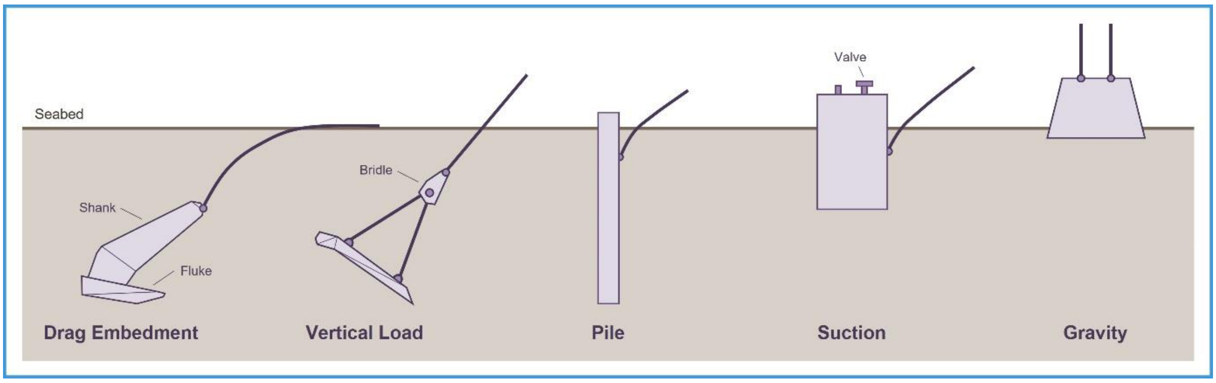


Figure 4-10 Indicative Anchor Types

Drag Embedment Anchor

4.7.4.4 A drag embedment anchor consists of a steel or concrete body with a streamlined shape, resembling a large arrow or plough. It typically has flukes or blades that help it penetrate the seabed. The design allows the anchor to use the drag force generated by its movement to embed itself deeper into the seabed, providing its holding capacity.

4.7.4.5 Drag embedment anchors are primarily used for catenary or semi-taut moorings, where the end of the mooring lines and their associated loads are horizontal to the seabed. They are not suitable for significant vertical loading.

4.7.4.6 Drag embedment anchors are installed by anchor handling vessels which pull the anchor along the seabed using the mooring line until the required depth and holding capacity is reached. To function correctly they need to be fully embedded into the seabed. Drag embedment anchors use soil resistance to hold the anchor in place and are best suited for sandy soils and cohesive sediments.

4.7.4.7 A secondary, or 'reaction', anchor may be used during the installation process to reduce the required installation loads (i.e. the maximum bollard pull) on the anchor handling vessel. This secondary anchor would be put in place temporarily for each main anchor deployment and then removed after installation is complete. The seabed impact from the deployment of these secondary anchors is included in the installation seabed impact given in **Table 4-7.**

4.7.4.8 After installation, there is no permanent footprint of the drag embedment anchor on the seabed, only the entry point of the mooring line remains.

Vertical Load Anchor

4.7.4.9 A vertical load anchor (also referred to as a plate anchor) consists of a large steel plate that is typically circular or square in shape. It is designed to be embedded in the seabed and provides its holding capacity through friction and the weight of material above the plate. The design may include features such as teeth, ribs, or rough surfaces on the underside of the plate to enhance its holding capacity by increasing friction with the seabed.

4.7.4.10 Vertical load anchors are primarily used for catenary or semi-taut moorings, but unlike drag embedment anchors, they can withstand both horizontal and vertical loads and are therefore suitable for a wider range of mooring configurations.

4.7.4.11 Vertical load anchors can be installed in a similar manner to drag embedment anchors, i.e. by an anchor handling vessel which pulls them along the seabed using the mooring line until embedded. To function correctly they need to be fully submerged into the seabed.

4.7.4.12 Alternatively, vertical load anchors can be installed using suction embedment, where a suction caisson is deployed from a support vessel and placed over the anchor to push it into the seabed. The suction caisson is then removed, leaving the anchor in place. The mooring line can either be attached to the anchor prior to suction embedment or connected to the anchor during the installation process by a subsea Remotely Operated Vehicle (ROV).

4.7.4.13 After installation, there is no permanent footprint of the vertical load anchor on the seabed, only the entry point of the mooring line remains.

Pile Anchor

4.7.4.14 A pile anchors consist of one or more cylindrical piles made of steel or concrete that are embedded in the seabed and provide holding capacity through a combination of direct load bearing and friction with the surrounding soil.

4.7.4.15 Pile anchors are primarily used for taut, semi-taut or tension moorings, due to their ability to resist both vertical and horizontal loads, but they can also be used with catenary mooring systems.

4.7.4.16 Driven pile anchors for a floating offshore wind farm are installed using an impact hammer or vibro-hammer which drives the piles into the seabed to the required depth. The piling occurs underwater using an offshore construction vessel located on the sea surface. The typical sequence followed is to lift the subsea pile template into place on the seabed, the pile is then lifted vertically into the pile template using an internal lifting tool, the hammer is then lowered (potentially with a follower) onto the pile. The number of blows and total time taken to install each pile depends upon the chosen hammer, the size of the pile and the properties of the soil at the specific location. Once the pile is installed the pile template is recovered to the construction vessel for use at the next position. An indicative drawing is shown in **Figure 4-11**. The parameters of the worst-case pile driving scenario are set out in **Section 4.7.6.8.**

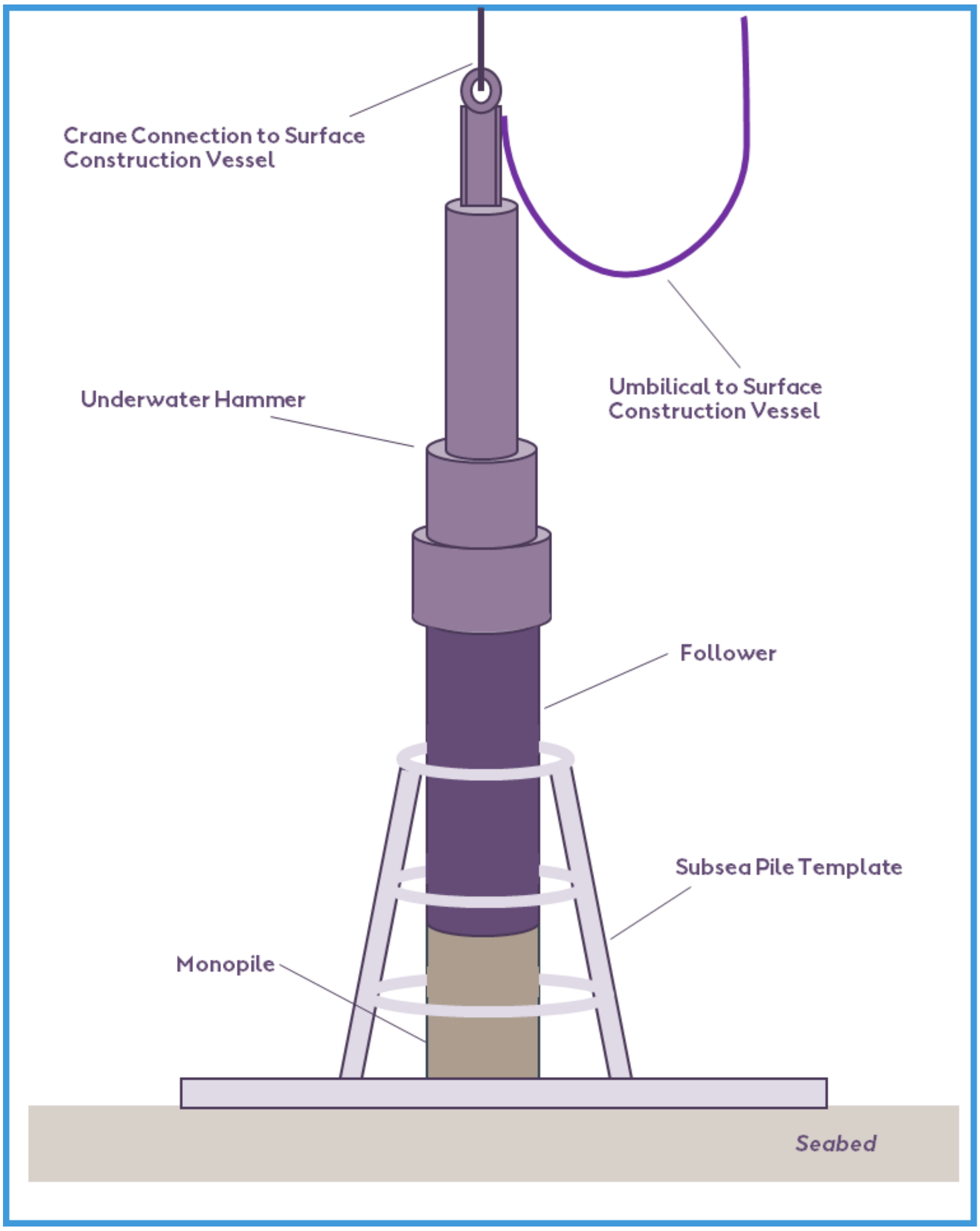


Figure 4-11 Example set-up of equipment used to drive sub-sea piles for mooring anchors

4.7.4.17 As an alternative to driven pile anchors, the Salamander Project may choose to use screwed (or helical) pile anchors, which are installed by screwing into the seabed and consequently generate less noise and vibration during installation.

4.7.4.18 As a further alternative, the Salamander Project may choose to use drilled piles. Each anchor could comprise either a single large pile or a cluster of small cylindrical 'micro' piles. Drilling is performed by a subsea drill spread or a drill rig mounted on a construction vessel and may also involve the installation of a casing using a conventional piling hammer. Drilled piles may consist of either a conventional steel pile placed into the hole, potentially with grouting between the casing and the pile, or are created by placing central reinforcing bars into each hole which are then filled with cementitious grout to allow loads to be transferred into the bearing soil or rock.

Suction Anchor

4.7.4.19 A suction anchor (also known as a suction pile or a suction caisson) consists of a steel upside-down 'bucket' from which the seawater is pumped out, creating a pressure differential that drives the structure into the seabed. Suction anchors minimise noise impacts during installation but are only feasible in specific seabed conditions, such as sands and clays. The suction created by the anchor provides the holding capacity of the anchor, combined with some friction with the surrounding soil.

4.7.4.20 Suction anchors are primarily used for taut, semi-taut or tension moorings, due to their ability to resist vertical loads, but they can also be used with catenary mooring systems.

4.7.4.21 Suction anchors are installed from a construction vessel, typically using a crane or winch to lower the anchor onto the seabed in the desired location. Water is then evacuated from within the anchor using a suction pump. As the water is removed, a pressure differential is created inside the anchor, causing it to push further into the seabed until the desired depth is reached.

4.7.4.22 If the desired depth is not quite reached, grout may be injected between the bucket and the seabed to fill-in any voids at the top of the suction caisson.

4.7.4.23 As an alternative to conventional suction anchors, the Salamander Project may choose to use screwed (or helical) caisson anchors, which combine a suction caisson structure with a cluster of small helical piles, placed within the footprint of the anchor. The helical piles are used to screw the caisson into the seabed using a hydraulic or electrical tool and are left in place after installation to provide additional holding capacity.

Gravity Anchor

4.7.4.24 A gravity anchor consists of a large mass which provides holding capacity due to its weight. Gravity anchors typically require medium to hard soil conditions and may become partially embedded in the seabed.

4.7.4.25 Gravity anchors are primarily used for taut, semi-taut or tension moorings, due to their ability to resist vertical loads, but they can also be used with catenary mooring systems.

4.7.4.26 Gravity anchors are installed by being lowered onto the seabed by a support vessel. Where the seabed is irregular, grout may be injected under the gravity anchor to establish an even contact profile with the soil and avoid high structural loads due to uneven support. A small caisson structure may also be present on the base of the anchor which penetrates a short distance into the seabed to improve the contact further.

Table 4-7 Worst-case Design Scenario – Anchors

Component	Drag Embedment	Vertical Load	Pile	Suction	Gravity
Number of Anchors per Floating Substructure	≤ 8	≤ 8	≤ 8	≤ 8	≤ 8
Total Number of Anchors	≤ 56	≤ 56	≤ 56	≤ 56	≤ 56
Anchor Dimensions	≤ 7 x 4 m	≤ 4 x 4 m	≤ 3 m (diameter)	≤ 7 m (diameter)	≤ 13.5 m (diameter)
Anchor Penetration Depth	≤ 20 m	≤ 25 m	≤ 70 m	≤ 35 m	≤ 3 m
Anchor Height above Seabed (after Installation)	0	0	≤ 3 m	≤ 3 m	≤ 5 m
Total Seabed Disturbance (incl. Installation)	≤ 78,400 m^2	≤ 22,400 m^2	≤ 9,900 m^2	≤ 32,100 m^2	≤ 125,900 m^2
Total Seabed Footprint of Installed Anchors	0 m^2	0 m^2	≤ 400 m^2	≤ 2,200 m^2	≤ 8,100 m^2
Total Area of Scour Protection on Seabed	0 m^2	0 m^2	≤ 9,500 m^2	≤ 29,900 m^2	≤ 117,800 m^2
Total Volume of Scour Protection on Seabed	0 m^3	0 m^3	≤ 19,100 m^3	≤ 59,900 m^3	≤ 266,300 m^3
Height of Scour Protection	-	-	≤ 2 m	≤ 2 m	≤ 2 m
Total Volume of Grout	0 m^3	0 m^3	≤ 10,000 m^3	≤ 3,100 m^3	≤ 4,100 m^3
Total Spoil Volume (from Drilling / Dredging)	0 m^3	0 m^3	≤ 27,800 m^3	≤ 36,300 m^3	≤ 48,600 m^3

Seabed Preparation and Scour Protection

4.7.4.27 Prior to installation of the anchors, there may be a need to perform a range of activities to prepare the seabed, to allow safe and precise installation and ensure the reliability of the anchors throughout the life of the Salamander Project. These activities may include boulder clearance, levelling of the seabed and rock placement (i.e. installation of a filter layer) and are typically carried out from a range of support vessels, see **Section 4.7.8** for more details. This may result in a certain amount sediment spoil, as set out in **Table 4-7**.

4.7.4.28 Depending on the anchor solution selected there may also be a requirement to install scour protection after installation to prevent the structure being undermined by sediment processes and seabed erosion. The preferred scour protection solution comprises a rock armour layer resting on a filter layer of smaller graded rocks. Alternatively, by using heavier rock material with a wider gradation, it is possible to avoid using a filter layer and install a single layer of scour protection.

4.7.4.29 The amount of scour protection required will vary for the different anchor types being considered, as set out in **Table 4-7**. The maximum diameter of the rocks used would be approximately 1 m and the maximum thickness of scour protection layer would be approximately 2 m.

4.7.5 Offshore Cables

4.7.5.1 Offshore cables are used for the transfer of power between the floating wind turbines, and from the offshore wind farm to the Landfall. The Salamander Project will use HVAC cables, operating at 66 kV.

4.7.5.2 The Salamander Project may install up to eight inter-array cables between the individual WTGs, as well as any subsea hubs (see **Section 4.7.6**), to collect their power output, and up to two offshore export cables between the Offshore Array Area and Landfall to export the power produced. The worst-case design scenario for offshore cables is shown in **Table 4-8**.

Design

4.7.5.3 The offshore cables typically consist of the following items, as shown in **Figure 4-12**, although this can vary depending on the specific supplier and/or project design: up to three conductors of either copper or aluminium, insulation for the conductors, screens for the conductors and insulation, filler material, optical fibres, sheath (bedding), bindings, armour wire (multiple layers depending on design) and an outer jacket.

4.7.5.4 Due to the use of floating substructures, the Salamander Project will require the use of dynamic cables for all or part of the inter-array connections between WTGs. Dynamic cables are able to accommodate movement of the floating substructures without imparting excessive loads on the cables.

4.7.5.5 The dynamic cables between WTGs will be suspended within the water column, and depending on the chosen configuration, may also 'touch down' and run along or through the seabed for a portion of their length, as shown in **Figure 4-13**. Dynamic cables will only be present within the Offshore Array Area. Any cables running between the Offshore Array Area and Landfall will touch down on the seabed before leaving the Offshore Array Area and no dynamic cable sections will be present in the Offshore ECC.

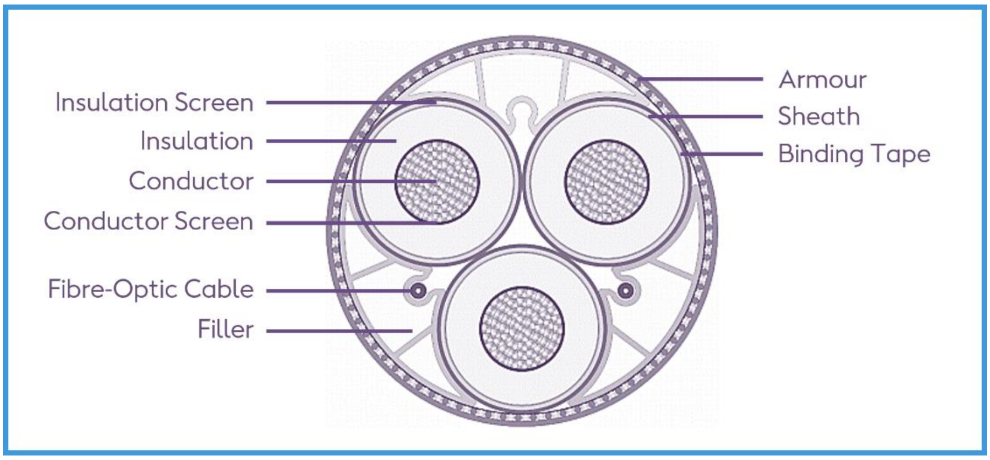


Figure 4-12 Indicative Cross-Section through an Offshore Cable

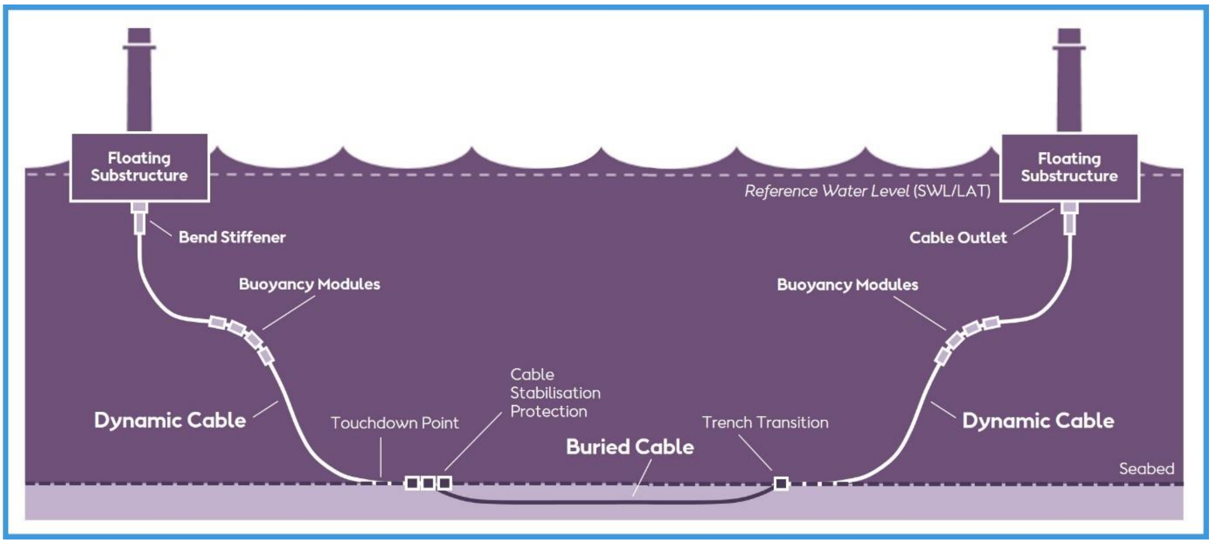


Figure 4-13 Components of the Offshore Cable System

4.7.5.6 The dynamic cable sections may be equipped with a combination of buoyancy modules, bend stiffeners, subsea buoys and / or seabed tethers, along with associated anchoring structures, in order to achieve the desired configuration for the cable. The Salamander Project may choose to use either a 'lazy-wave', 'lazy-S' or 'lazy-U' configuration, as shown in **Figure 4-14**, depending on the chosen floating substructure and the conditions on site.

4.7.5.7 The lazy wave configuration provides lift at a midwater cable section through buoyancy modules attached to the dynamic cable. This buoyant section decouples the expected motions of the floating substructure from the fixed subsea cable end. A cable tether may be used to restrain the touchdown point and reduce the range of movement of the cable. They dynamic cable may also terminate to a fixed support structure on the seabed, in a configuration known as a 'steep wave'.

4.7.5.8 The lazy 'S' configuration is similar to a lazy wave but tethered buoyancy modules or a single subsea buoy (sometimes called a 'mid-water arch') are used instead of free-floating buoyancy modules attached directly to the cable. This configuration can tolerate a wider range of lateral motion by the floating substructure and the tethering of the buoyancy modules also reduces cable excursion due to currents. Additionally, if required, a single subsea buoy can be shared by multiple cables entering the same floating substructure.

4.7.5.9 The lazy 'U' configuration (sometimes referred to as a 'Chinese lantern' configuration) includes a U-shaped section of cable slack supported by buoyancy modules that keeps the tether vertically aligned with the cable entry in the floating substructure. This configuration can tolerate a wider range of vertical motion of the floating substructure, but a smaller range of lateral motion.

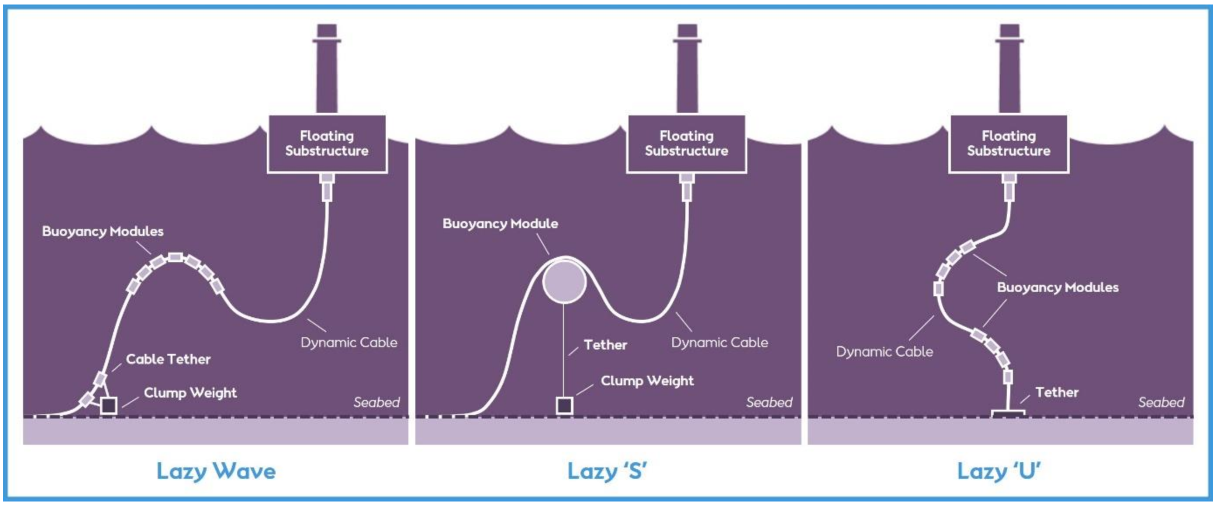


Figure 4-14 Indicative Dynamic Cable Configurations

4.7.5.10 The buoyancy modules are typically constructed as cylindrical or elongated structures, with a durable external shell and filled with buoyant materials, such as polyethylene or polyurethane foams, or syntactic foam, which consists of a mixture of hollow glass and / or polymer microspheres and a binding matrix, such as epoxy resin. The number of modules required and their position within the water column will be driven by a combination of factors such as: water depth, environmental conditions, metocean conditions and the desired dynamic cable configuration.

Table 4-8 Worst-case Design Scenario – Offshore Cables

Component	Within the Offshore Array Area	Within the Offshore Export Cable Corridor
Total Combined Length of Offshore Cables	≤ 35 km	≤ 85 km
Individual Cable Outer Diameter	140 – 320 mm	140 - 320 mm
Dynamic Cable Segments		
Total Length of Cable suspended in Water Column	≤ 3,500 m	-

Component	Within the Offshore Array Area	Within the Offshore Export Cable Corridor
Total Length of Buoyancy Module Sections	≤ 1,400 m	-
Outer Diameter of Buoyancy Modules	≤ 1.5 m	-
Contact Length with Seabed (per Dynamic Cable)	≤ 500 m	-
Total Area of Seabed swept by Dynamic Cables	≤ 700,000 m^2	-
Number of Cable Tethers (per Dynamic Cable End)	≤ 4	-
Seabed Footprint of Cable Tether Anchors	≤ 20 x 20 x 10 m	-
Total Seabed Footprint of Cable Tether Anchors	≤ 22,400 m^2	-
Static Cable Segments		
Width of Cable Installation Corridors	≤ 40 m	≤ 40 m
Spacing between Adjacent Cable Corridors	≥ 100 m	≥ 20 m
Total Seabed Disturbance during Installation	≤ 1,400,000 m^2	≤ 3,400,000 m^2
Total Combined Length of Cable Trenches	≤ 35 km	≤ 85 km
Burial Trench Width (Jetting, Cutting, Vertical Injection)	≤ 5 m	≤ 5 m
Burial Trench Width (Ploughing, Mass Flow Injection)	≤ 7.5 m	≤ 7.5 m
Target Cable Depth of Lowering (subject to CBRA)*	> 0.6 m	> 0.6 m
Total Spoil Volume from Cable Burial	≤ 262,500 m^3	≤ 637,500 m^3

* The exact target depth of lowering will be based on a CBRA with consideration of seabed conditions and potential threats to the cables and may vary throughout the Offshore Development.

4.7.5.11 Bend stiffeners are used to reduce cable fatigue at key points. The connection between a floating substructure and its dynamic cable(s) can be subject to movements from both components, as opposed to just the cable system in the case of a fixed foundation. The Salamander Project may use bend stiffeners or bend restrictors at the cable exit from the floating substructures and at the touch-down/tie-down point of the cable on the seabed.

4.7.5.12 The tethers used to restrain the movement of the dynamic cable sections are held in place using clump weights and / or gravity anchors (see **Section 4.7.4**). These are laid on the seabed and tethered to the cable or the buoyancy modules, either individually or in pairs with one anchor either side of the cable section.

4.7.5.13 Where technically feasible, the Salamander Project may choose to trench and/or bury the portions of the cable running along the seabed for their protection. The final burial method and target depth of lowering will be defined post-consent based on a CBRA (or similar) considering ground conditions and the potential impacts on cables from trawling, vessel anchors, etc. Cable depths of lowering are typically 1 – 2 m where technically feasible, with a minimum target depth of lowering of 0.6 m; this will vary depending on seabed conditions.

Layout

4.7.5.14 A number of WTGs will typically be grouped together on a cable 'string', which can be arranged in a number of configurations such as linear, fishbone, star and loop. Adjacent strings can also be linked together to create a ring configuration.

4.7.5.15 These strings will either transmit power directly to shore, be connected to a subsea hub(s) or jointed together to reduce the number of cables that run to shore, as shown in **Figure 4-15**. The subsea hub(s) or array joint(s) provides a termination for the cables used to transmit electrical power and communication signals from the WTGs and a connection to the cables used to export the power to shore.

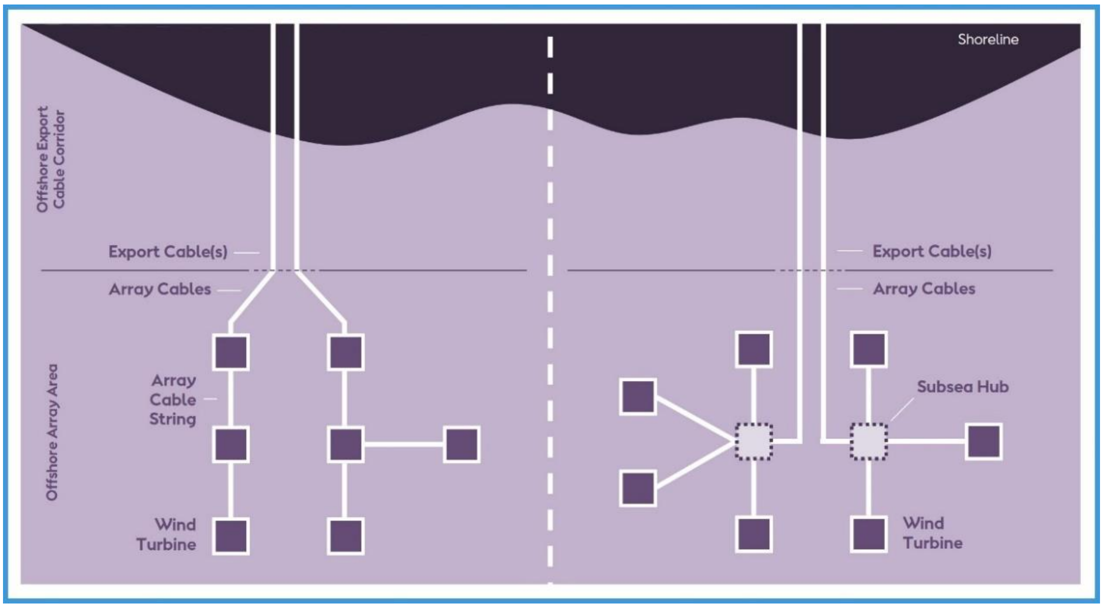


Figure 4-15 Indicative Offshore Cable Layout Configurations

4.7.5.16 The transition from inter-array cable to offshore export cable is defined as the boundary of the Offshore Array Area, however there may be no physical change in the cable at that point. Where an inter-array cable transitions directly into an offshore export cable, the dynamic-to-static transition for these cables will have taken place within the Offshore Array Area and no dynamic cable sections will be present in the Offshore ECC.

Cable Installation

4.7.5.17 Pre-lay surveys of proposed cable corridors will be undertaken to identify any requirement for obstacle removal along the buried portion of the cable route. If required, identified obstacles such as boulders, UXO and discarded fishing gear will be removed pre-construction and during construction along the proposed cable route (clearance of UXO if required would be consented via a separate Marine Licence application).

4.7.5.18 The Salamander Project may also need to plough or dredge the cable route prior to installation to level any sandwaves that may hinder installation. See **Section 4.7.8** for more details.

4.7.5.19 The cable sections are loaded onto the installation vessel which includes a carousel or reel drive system and tensioner/lay spread. The vessel moves to the site of a pre-installed floating substructure and the cable is pulled into the floating structure using a messenger wire and secured. The cable is then deployed into the water column and the vessel transits along the desired route, laying cable on the seabed as it goes. For inter-array cables, the second end of the cable is then deployed and pulled and secured into another floating substructure, while for offshore export cables, the cable will be pulled into a TJB or the OnSS at Landfall.

4.7.5.20 Alternatively, the inter-array cables may be pre-installed and wet-stored (potentially over a full winter period) until the floating substructure is brought to site. The inter-array cable is then hooked-up to the floating structure once it has been connected to its moorings. The wet-storage procedure requires waterproofed sealing at the free cable ends. The inter-array cable also needs to be fitted with appropriate rigging to enable safe recovery for later pull-in and connection. Additional items may also need to be deployed and recovered as part of the wet-storage process, including mats, sandbags, clump weights and buoyancy aids.

4.7.5.21 Any buoyancy modules and / or tethers will be attached to the dynamic inter-array cable segments during deployment and are installed simultaneously with the cables from the same vessel.

Cable Burial

4.7.5.22 It is currently intended that the offshore export cable(s) will be sufficiently buried beneath the seabed, however, in the event that the soil conditions do not facilitate this, post-installation cable protection measures will be implemented as described in **Sections 4.7.5.36** to **4.7.5.43**. The potential burial methods which could be applied are described below.

4.7.5.23 Cable burial for all static sections of cable can be performed either simultaneously with cable laying, using a dedicated tool towed behind the installation vessel, or as a separate post-lay burial activity, where a separate burial vessel positions a tool over the previously laid cable and moves along the cable route to bury the cable to the desired depth. Post-lay burial may also be used if successful burial is not achieved in a single pass by the cable laying vessel. Multiple passes may be made over the cable route by the burial tool to achieve the desired depth.

4.7.5.24 The cable may also be installed by pre-trenching whereby a trench is opened up by a separate trenching vessel prior to cable laying, and the cable then subsequently laid into the pre-prepared trench. A separate backfill tool may then be used to push the spoil heaps created by trenching over the cable, creating the required cable cover.

4.7.5.25 Possible trenching and burial methods include jetting, ploughing, vertical injection, cutting and Mass Flow Excavation (MFE, sometimes referred to as Controlled Flow Excavation). The methods used may vary across the Offshore Array Area and Offshore ECC depending on the characteristics of the seabed sediments.

4.7.5.26 Jetting involves a subsea device (usually an ROV) injecting water at high pressure into the sediment surrounding the cable, which temporarily fluidises the seabed and allows the cable to be lowered to the desired depth under its own weight. Displaced material is suspended in the water and then resettles over the cable. Jetting is best suited to softer soils such as silt or sand.

4.7.5.27 Ploughing involves guiding the cable into a self-closing furrow cut by a sea plough towed by a vessel on the surface. As the plough passes across the seabed, the share opens the furrow, inserts the cable, and allows sediment to fall back, filling the fissure. The plough may also be used to create a stand-alone trench as part of a pre-trenching campaign. Different plough designs are available to suit a range of different soils, but all require the seabed to be relatively homogenous and free from obstacles.

4.7.5.28 Vertical injection involves use of a jet-assisted plough, consisting of a jetting head with water nozzles on the leading edge, through which the cable is routed. Vertical injection is typically used for deeper burial in jet-able soils and is able to handle steeper seabed slopes than other burial tools.

4.7.5.29 Cutting may be required in areas of harder cohesive soils and soft rock, as well as in organic soils, and involves the use of a tracked ROV equipped with a mechanical chain or wheel cutting head to physically cut into the seabed to create a trench for the cable.

4.7.5.30 MFE is a versatile option for trenching, post-lay burial or to remove sediment from areas prior to cable installation. These tools involve directing water at the seabed via a ducted nozzle to excavate the seabed to the desired depth.

4.7.5.31 Trenching and burial tools are deployed from a host vessel, usually via a crane, and move along the seabed either on a skid, a tracked vehicle or an ROV. They may contain a range of tool-mounted sensors to ensure accurate positioning and control.

4.7.5.32 Upon completion of burial, a post-burial survey may be carried out by the burial vessel to assess whether the cable is at the correct position and required depth of lowering.

Cable Jointing

4.7.5.33 Where separate dynamic and static cable sections are used, the two segments will need to be jointed. Joints may also be needed between sections of static export cable. This can be achieved using either permanent or mate-able joints. The worst-case design scenario for the subsea joints is shown in **Table 4-9**.

4.7.5.34 Mate-able joints enable the two sections of cable to be disconnected and re-connected without harm, while permanent connections can only be separated by cutting the cables. Mate-able joints can be either dry-mate or wet-mate connectors: dry-mate joints need to be assembled on board the installation vessel, while wet-mate joints can be connected underwater by an ROV.

4.7.5.35 Where lengths of cable are jointed to one another it is not possible to bury the cable joint using conventional cable burial tools. It may therefore be necessary to excavate a jointing pit to accommodate the joint and ensure its protection. The pit will normally be excavated via a dredging vessel and backfilled once jointing is complete. If the cable joint cannot be buried, it will be secured on the seabed and scour protection installed to stabilise the position of the cable.

Table 4-9 Worst-case Design Scenario – Cable Jointing

Component	Within the Offshore Array Area	Within the Offshore Export Cable Corridor
Number of Subsea Joints	≤ 16	≤ 4
Subsea Joint Dimensions	≤ 6 x 2 x 2 m	≤ 6 x 2 x 2 m
Height of Subsea Joint above Seabed	≤ 3 m	≤ 3 m
Total Area of Scour Protection for Cable Joints	≤ 64,000 m^2	≤ 16,000 m^2

Component	Within the Offshore Array Area	Within the Offshore Export Cable Corridor
Total Volume of Scour Protection Material	≤ 66,000 m^3	≤ 16,500 m^3

Cable Stabilisation and Protection

4.7.5.36 Cables will need to be made secure where the route crosses obstacles such as exposed bedrock, pre-existing cables or pipelines, which prevent the cable from being buried. There also may be instances where ground conditions do not allow cables to be adequately buried and some form of armouring is needed to maintain the integrity of the cable.

4.7.5.37 Where technically feasible, the Salamander Project will attempt to bury the offshore cables on the seabed. However, as a worst-case scenario, it is estimated that up to 20% of the static cabling within both the Offshore Array Area and the Offshore ECC may require additional remedial cable protection. The requirements for cable protection will be reviewed during detailed design to minimise cable protection volumes where possible, within the worst-case design scenario set out in **Table 4-10**.

4.7.5.38 The Salamander Project may use a range of cable protection methods, including: rock placement, rock bags, concrete mattresses, frond mattresses or articulated pipe.

4.7.5.39 Rock placement involves a fall pipe vessel placing rocks of different grades over the cable. Initially smaller stones are placed over the cable as a covering layer. This provides protection from any impact from larger grade size rocks, which are then placed on top of this smaller scale layer. Rock placement can provide protection from both direct anchor strikes and anchor dragging. This rock grading generally has mean rock sizes in the range of 90 to 125 mm, up to a maximum of 250 mm. Bigger rocks may be necessary if protection from larger anchors is required (e.g. up to 500 mm in shipping corridors).

4.7.5.40 The rocks generally form a trapezium shape, up to approximately 1.5 m above the seabed with a 3:1 gradient (see **Figure 4-16**). The cross section may vary depending on expected scour. The length of the berm is dependent on the length of cable which is either unburied or has not achieved target depth.

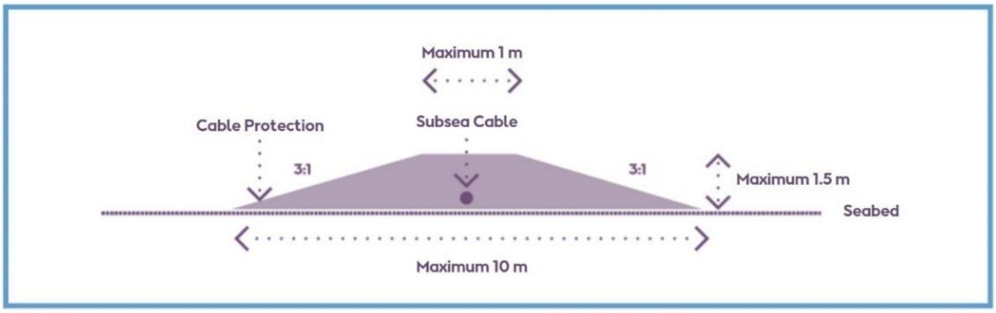


Figure 4-16 Indicative Cable Protection Berm

4.7.5.41 Rock bags consist of various sized rocks constrained within a rope or wire netting containment. They are placed via a crane and deployed to the seabed.

4.7.5.42 Mattresses are formed by interweaving a number of concrete blocks with rope and wire. They are lowered to the seabed on a frame. Once positioning over the cable has been confirmed, the frame release mechanism is triggered, and the mattress is deployed. This single mattress placement will be repeated over the length of cable which is either unburied or has not achieved target depth.

4.7.5.43 Frond mattresses are installed following the same procedure as general mattress placement operations. They include fronds designed with the aim to form protective, localised, sand berms.

4.7.5.44 Articulated pipe, which is typically made of cast-iron, is directly clamped over the cable while it is being laid on the seabed. The weight and material stabilises the cable in the applicable environmental conditions and is very resistant to abrasion. Application will be in areas where there is bedrock at or near the surface, meaning the cable cannot be buried sufficiently into the seabed. For the Salamander Project, this would most likely be in the nearshore area, where it has not yet been possible to acquire survey data, and the presence of bedrock is possible.

Table 4-10 Worst-case Design Scenario – Cable Stabilisation and Protection

Cable Stabilisation and Protection	Within the Offshore Array Area	Within the Offshore Export Cable Corridor
Portion of Cable Length requiring Protection	≤ 20%	≤ 20%
Width of Cable Protection Berm	≤ 10 m	≤ 10 m
Height of Cable Protection Berm	≤ 1.5 m	≤ 1.5 m
Total Seabed Footprint of Cable Protection	≤ 70,000 m^2	≤ 170,000 m^2
Total Volume of Cable Protection Material	≤ 57,750 m^3	≤ 140,250 m^3

Cable Crossings

4.7.5.45 Within the Offshore ECC the export cable(s) will need to cross the existing Fulmar to St. Fergus gas pipeline, and it may also be necessary to cross future export cables from other offshore projects that are currently in development. Where this occurs, both the third-party asset and the installed cable must be protected. The design and methodology of these crossings will be confirmed in agreement with the asset owners, within the worst-case design scenario set out in **Table 4-11**.

4.7.5.46 A protection layer will be placed over the existing asset for its protection. This may be a pre-lay rock berm, or a separation layer make of an alternative protection material such as rock bags or concrete mattresses. This layer may be up to 50 cm thick with a rectangular or oval plan view.

4.7.5.47 The Salamander Project offshore export cable(s) will then be laid across this at an angle as close to 90 degrees as practicable and then be covered with a layer of cable protection material to ensure that the offshore export cable(s) remain protected and in place throughout the lifetime of the project. A range of protection materials may be considered including rocks, rock bags, concrete mattresses or frond mattresses. An overview of this arrangement is shown in **Figure 4-17**.

Table 4-11 Worst-case Design Scenario – Cable Crossings

Component	Within the Offshore Array Area	Within the Offshore Export Cable Corridor
Number of Crossings of 3rd-Party Infrastructure	0	≤ 24[5]
Height of Cable Crossing Berm	-	≤ 2 m
Total Seabed Footprint of Cable Protection	-	≤ 158,160 m^2
Total Volume of Cable Protection Material	-	≤ 99,600 m^3

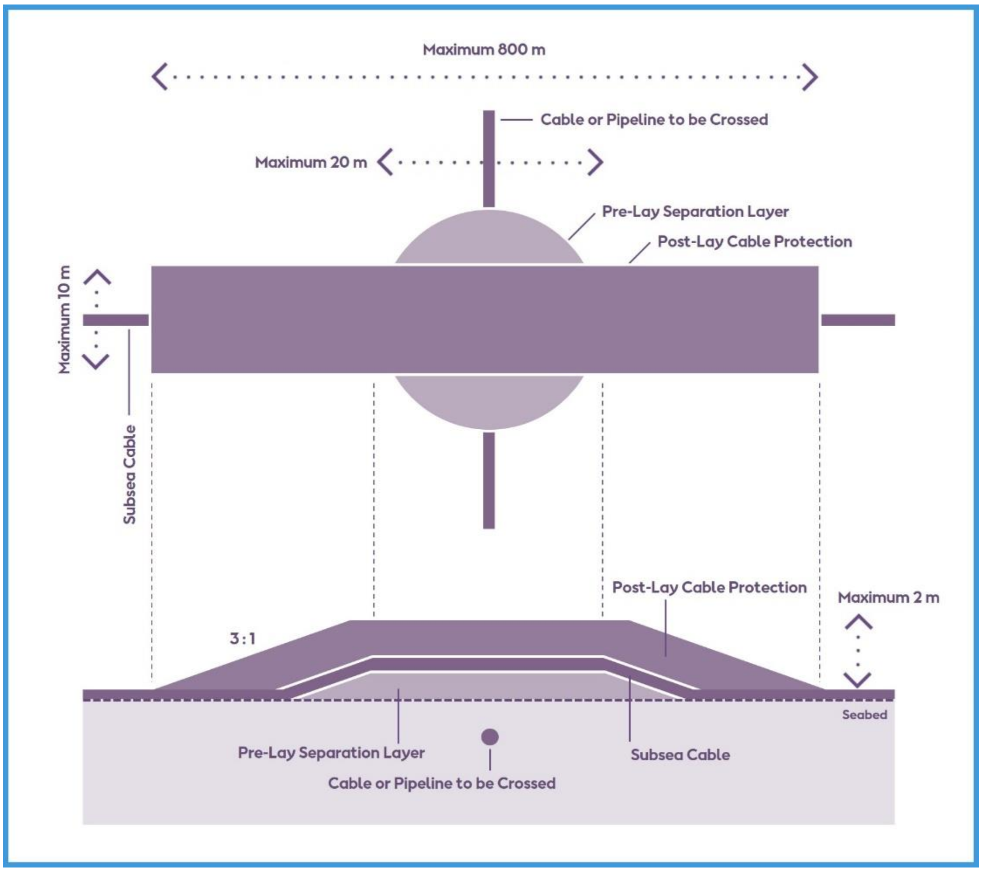


Figure 4-17 Indicative Cable Crossing Cable Protection Arrangement

[5] The total number of potential crossings is based upon the crossing of four assets (see **ER.A.4, Annex 4.2: Crossing Schedule (Offshore)).**

4.7.6 Subsea Hubs

4.7.6.1 As part of the export system, the Salamander Project may deploy up to two subsea hubs within the Offshore Array Area, which allow the connection of inter-array cables from multiple WTGs to a single outgoing cable, allowing for greater flexibility in floating offshore wind farm layout design and construction.

Design

4.7.6.2 Each subsea hub consists of a gravity-based skid supporting a junction box, a series of wet-mate receptacles to connect the individual WTG cables, and either a wet- or dry-mate connector for the outgoing cable, as shown in **Figure 4-18**. It may also include a smaller wet-mate receptacle to allow the connection of subsea instrumentation and monitoring equipment. The worst-case design scenario for the subsea hubs is shown in **Table 4-12**.

Depending on seabed mobility and loading, it is anticipated that the subsea hub will simply rest on mud matts and friction will prevent movement, alternatively the feet of the structure may be pointed so that they slightly penetrate the seabed surface to maintain the hub in place. However, if additional anchoring is required this may be achieved by dead man anchors, suction bucket anchors, or small subsea piles.

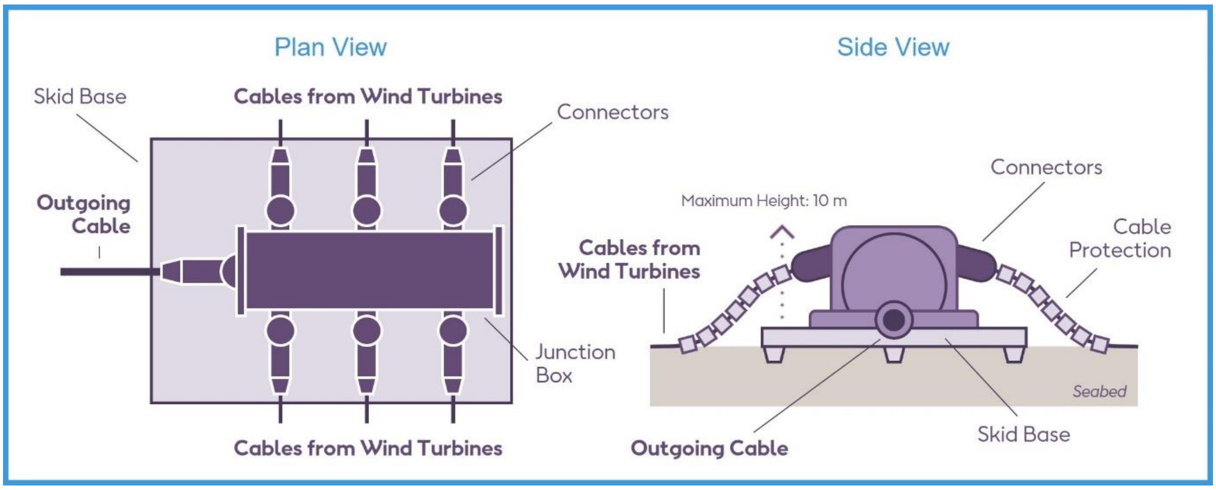


Figure 4-18 Indicative Subsea Hub

4.7.6.3 Scour protection may be installed around the subsea hubs to stabilise their location and protect against seabed erosion. The preferred scour protection solution comprises a rock armour layer resting on a filter layer of smaller graded rocks. Alternatively, by using heavier rock material with a wider gradation, it is possible to avoid using a filter layer and install a single layer of scour protection.

4.7.6.4 The offshore cables may be equipped with bend protectors and / or cable protection systems where they are connected to the subsea hub.

Installation

4.7.6.5 For installation, the subsea hub is loaded onto a suitable offshore construction vessel, equipped with a heave compensated crane, and transported out to the desired location. The subsea hub is lifted and lowered onto the seabed where a work-class ROV may be used to monitor the final positioning and to assist with the detachment of rigging and the hook-up of the cables.

4.7.6.6 If the outgoing cable is connected via a dry-mate connector, this cable is recovered to the deck of the installation vessel for mating to the subsea hub prior to installation. The wet-mate connectors are connected after deployment of the subsea hub using an ROV.

Table 4-12 Worst-case Design Scenario – Subsea Hubs

Component	Design Envelope
Number of Subsea Hubs	≤ 2
Seabed Hub Dimensions	≤ 15 x 15 m
Height of Subsea Hub	≤ 10 m
Number of Anchor Piles	≤ 12
Anchor Pile Dimensions	≤ 1.5 x 30 m
Total Seabed Disturbance from Subsea Hubs	≤ 7,000 m^2
Height of Scour Protection	≤ 2 m
Total Volume of Scour Protection on Seabed	≤ 4,200 m^3
Height of Cable Protection	≤ 1.5 m
Total Volume of Cable Protection Material	≤ 4,125 m^3

4.7.6.7 Ballast (cast iron, reinforced concrete and / or sand) may be added to the subsea hub if necessary to maintain it on the seabed.

4.7.6.8 Cable stabilisation protection (rock bags, mattresses or similar, see **Section 4.7.5**) may also be placed along the cables for approximately 500 m on the approach to the subsea hub to ensure they are stable.

4.7.7 Piling and Drilling

4.7.7.1 Piling and / or drilling may be required as part of the installation of the anchors for the floating substructures and / or the subsea hubs. A Piling Strategy (PS) will be prepared for the Salamander Project if impact piling is selected as the optimal installation mechanism. The strategy will provide full details of the piling activities and parameters, including expected noise levels, duration of activities and any required mitigations.

4.7.7.2 The base case hammer energy is up to 1,500 kilojoules (kJ) and up to four piles installed per day. In the instance of hard-driving being encountered during installation, where a pile is not making sufficient progress with each pile strike, the hammer energy shall be up to 2,500 kJ. Where up to 2,500 kJ is required there will be a 24 hour break in pilling before the next pile is installed. To minimise fatigue loading, hammer energies are continuously set at the minimum required, which also reduces the likelihood of breakdown of the equipment, hence will typically start low (10% soft start of 250 kJ) and gradually increase to the maximum required installation energy during piling of the final metres. A characteristic piling scenario with maximum durations for each energy level is provided in **Table 4-13**.

Table 4-13 Worst-case Design Scenario – Piling

Soft start and ramp up scenario 1,500 kJ					
Relative Energy	10%	10%	20%	40%	100%
Hammer Energy	150 kJ	150 kJ	300 kJ	600 kJ	1,500 kJ
Strike Rate	3 blows (bl)/min	30 bl/min	30 bl/min	30 bl/min	30 bl/min
Time	20 min	68 min	70 min	70 min	70 min
Soft start and ramp up scenario 2,500 kJ					
Relative Energy	10%	10%	20%	40%	100%
Hammer Energy	250 kJ	250 kJ	500 kJ	1,000 kJ	2,500 kJ
Strike Rate	3 bl/min	30 bl/min	30 bl/min	30 bl/min	30 bl/min
Time	20 min	38 min	40 min	40 min	160 min

4.7.7.3 Only one anchor will be piled at a time within the Offshore Array Area. Up to two piling vessels may be on site at the same time, but they would not pile at the same time; instead taking advantage of the downtime between piling activities to streamline the overall installation process. The maximum number of piles installed will be four piles in any 24-hour period.

4.7.7.4 If piling is not possible due to the presence of rock or hard soils, the material inside the pile may be drilled out before the pile is driven to the required depth. This can either be done in advance of the driving or if the piling rate slows significantly during installation. Drilling may also be used for the installation of drilled pile or micropile anchors (see **Section 4.7.4**) which is done as a standalone activity without any piling. If drilling is required, it is conducted at a speed of 0.5 to 1.0 m/hr with any spoil arising from the drilling becoming suspended in the water column and being deposited on the seabed across the surrounding area.

4.7.7.5 Guar gum may be used during drilling to regulate the viscosity of mud solution and stabilise the flow properties of the drilling muds. Guar gum is a natural product that is non-toxic, biodegradable and has no bioaccumulation potential. The suspension of guar gum, water and drilling spoil would be discharged into the water column with the spoil settling out onto the seabed.

4.7.7.6 Both piling and drilling may require the use of a 'template' placed on the seabed to guide the installation tool. This is typically a steel frame structure, deployed from the same vessel that will conduct the piling or drilling operation and recovered once the installation is complete. The footprint of this template would be located entirely within the total seabed areas set out in **Table 4-7** and would thus not result in any additional seabed impact.

4.7.7.7 Vibro-piling may also be used where the piles are embedded via vibration rather than hammering or drilling. If such methods were employed, it would be ensured that the noise emissions were within the envelope consented for hammering.

4.7.8 Ancillary Activities

4.7.8.1 A range of pre- and post-construction activities will be required to prepare the seabed for offshore construction and operation of the wind farm. These are detailed below.

Surveys and Measurement Campaigns

4.7.8.2 A number of offshore surveys and measurement campaigns will be conducted across the different stages of the Salamander Project's development, including pre-application surveys to inform the design and environmental impact of the project. Consent for the pre-application surveys will be sought separately but are described here to give a full overview of the range of activities planned by the Salamander Project. An illustrative overview of the timing of the different surveys is shown in **Figure 4-19**.

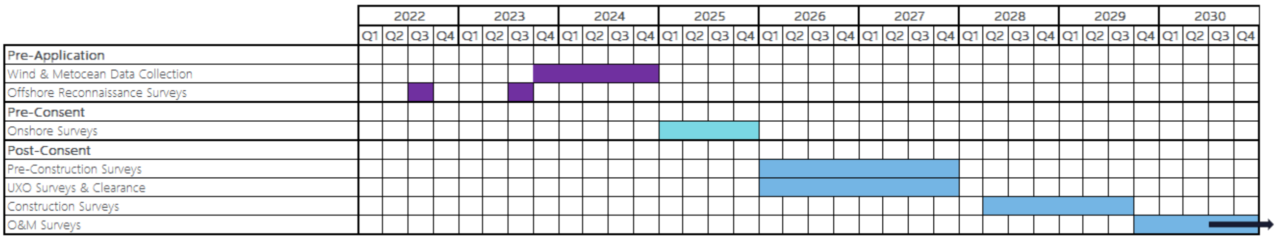


Figure 4-19 Indicative Survey Programme

4.7.8.3 Prior to this application, reconnaissance surveys have been undertaken to gain early insight into the site and seabed conditions within the Offshore Array Area and Offshore ECC and to collect data to inform both the EIA process and the preliminary design work within the Salamander Project. These included both geophysical and geotechnical surveys; further geophysical and geotechnical surveys may be needed to obtain the data within the nearshore area.

4.7.8.4 Geophysical surveys are used to provide further detailed bathymetry, bedform and boulder mapping across the Offshore Development Area, as well as a topographical overview of the seabed and an indication of its sub-layers. Geophysical surveys are performed utilising towed arrays and sonar, with no seabed interaction.

4.7.8.5 Geotechnical surveys are used to provide more targeted information about the seabed conditions in specific locations, typically within the footprint of the cables, anchors, subsea hubs and other seabed infrastructure. These are performed using techniques such as boreholes, cone penetration tests (CPTs), *in situ* thermal measurements and vibrocores.

4.7.8.6 For measurement of wind speeds onsite, the Salamander Project has deployed two floating LiDAR (Light Detection and Ranging) devices within the Offshore Array Area, which will remain in place for approximately 12 months before being fully removed.

4.7.8.7 For measurement of wave conditions, the Salamander Project has deployed a wave buoy within the Offshore Array Area, which will initially remain in place for up to 12 months to collect data to inform the design. Attached to bottom of the wave buoy is an acoustic doppler current profiler (ADCP) to measure current speeds. The buoy will be decommissioned and stored until it is redeployed to support the offshore construction activities. The buoy will remain in place throughout the construction phase and for a further 36 months at the start of operations to support verification and monitoring of the floating substructures. Wave buoys are held in place by an anchor and mooring line, with the maximum footprint given in **Table 4-14.**

Table 4-14 Worst-case Design Scenario – Post-Consent Measurement Campaigns

Component	Design Envelope
Number of Wave Buoys	≤ 1
Total Seabed Footprint of Devices Moorings	≤ 40 m^2

4.7.8.8 Once consent is granted, a number of pre-construction surveys will be undertaken before the start of offshore construction works in order to identify in detail the seabed conditions and morphology, confirm the presence/absence of any potential obstructions or hazards, and to verify seabed layers. These will consist of both geophysical and geotechnical surveys and will be conducted across the Offshore Array Area and Offshore ECC.

4.7.8.9 During and after construction, there will also be a range of surveys ongoing within the Offshore Array Area and Offshore ECC, including pre- and post-installation surveys of subsea infrastructure such as mooring lines, anchors, subsea hubs and offshore cables, as well as post-burial surveys of offshore cables. These will be used to confirm the success of the installation procedures and document the as-built condition of the assets. These surveys may include geophysical surveys and visual inspections using ROVs. Depth of burial surveys may use acoustic or electromagnetic survey techniques.

4.7.8.10 Once the Salamander Project enters the Operation and Maintenance (O&M) phase, offshore surveys continue to be necessary to monitor the condition of the assets, as described in **Section 4.9.**

4.7.8.11 During the Decommissioning phase, a similar range of offshore surveys will be used as during the Construction phase, as described in **Section 4.10.**

Unexploded Ordnance Clearance

4.7.8.12 It is common to encounter UXO originating from World War I or World War II during construction. This poses a health and safety risk where it coincides with the planned location of infrastructure and associated vessel activity, and therefore it is necessary to survey for and carefully manage UXO.

4.7.8.13 Targets identified during the pre-construction geophysical surveys that model as potential UXO can either be investigated to confirm their identity or avoided by a suitable distance. Investigation of the target is undertaken using an ROV and requires careful excavation of the potential UXO. Identification of the target will generally be made visually by on-board specialists monitoring camera footage. An immediate risk assessment will be carried out to enable a decision on the appropriate management required for each target.

4.7.8.14 Where a target is confirmed as non-UXO (i.e. to be inert) the device may be recovered for onshore disposal where practicable. Inert devices that cannot be practically moved will be left *in situ* with Salamander Project infrastructure to be micro-sited around the device.

4.7.8.15 Where a target is confirmed as an active UXO that cannot practicably be avoided, the UXO will be cleared, either via careful removal or disposal *in situ*.

4.7.8.16 It is not possible at this time to precisely define the number of UXO which may require detonation. As a result, a separate Marine Licence and European Protected Species (EPS) Licence will be applied for pre-construction for the clearance (where required) of any UXO which may be identified in pre-construction surveys. The net explosive quantity (NEQ) of items commonly found in the North Sea range from 25 kg to over 350 kg, however occasionally significantly larger UXO have been found in the North Sea. If UXO are found within the Offshore Development Area that require clearance, further assessment will be undertaken as part of the application for the separate Marine Licence for UXO clearance.

4.7.8.17 The Salamander Project will seek to minimise the impacts from UXO clearance, with the order of preference for the different techniques being:

- Avoidance, then;
- Recovery / Removal (lift-and-shift), then;
- Low-order disposal, e.g. deflagration (*where UXO specialists and HSE team advise safe to do so*), then;
- High-order disposal, e.g. detonation.

Boulder Clearance

4.7.8.18 Where large volumes of boulders are present in key areas, micrositing of infrastructure around these boulders may be onerous and impractical. If left *in situ*, boulders will pose a number of risks, including obstruction of and / or damage to cable and mooring installation equipment, inadequate cable burial, incomplete anchor installation, and a risk of damage to cable and mooring equipment during operations.

4.7.8.19 Within both the Offshore Array Area and the Offshore ECC, boulders greater than 0.3 m in any dimension must be cleared where these conflict with proposed seabed infrastructure locations, especially cables, anchors, and mooring lines. For offshore cables, a corridor of up to 40 m must be cleared per cable circuit to give sufficient width for operation of the cable burial tools.

4.7.8.20 There are two key methods of clearing boulders, boulder plough and boulder grab. Where a high density of boulders is seen, a plough will likely be used. Where medium and low densities of boulders are seen, a subsea grab is expected to be employed.

4.7.8.21 The total seabed disturbance from boulder clearance cannot be fully defined until more detailed geophysical survey work is complete, but the maximum disturbance will be within the limits set out in **Table 4-7** and **Table 4-8**.

Pre-Lay Grapnel Run

4.7.8.22 Following the pre-construction surveys and boulder clearance works, a Pre-Lay Grapnel Run (PLGR) and associated seabed clearance survey will be undertaken. A vessel will be mobilised with a series of grapnels, chains, a recovery winch and survey spread suitable for vessel positioning and data logging. Any obstructions identified will be recovered onto deck where possible and the results of this survey will be used to determine the need for any further clearance. The PLGR work will take account of and adhere to any archaeological protocols developed for the Salamander Project.

4.7.8.23 If the final route of the offshore cables crosses any out of service cables, these will be recovered to a vessel deck, where one end will be cut, in order to pull the cable past the crossing point. The cable will then be cut and pulled to the surface where it will be removed from site by the vessel. Any out-of-service cable removal will be carried out in consultation with the asset owner and in accordance with International Cable Protection Committee (ICPC) guidelines.

4.7.8.24 As with boulder clearance, the total seabed disturbance from the PLGR cannot be fully defined until more detailed survey work is complete, but the maximum disturbance remains within the limits set out in **Table 4-7** and **Table 4-8**.

Sandwave Clearance

4.7.8.25 In some areas within the Offshore Array Area and along the Offshore ECC existing sandwaves and similar bedforms may be required to be removed before cables are installed. This is done for two reasons. Firstly, many of the cable installation tools require a relatively flat seabed surface in order to work properly. Secondly, the cable must be buried to a depth where it may be expected to stay buried for the duration of the Salamander Project's lifetime. Sandwaves are generally mobile in nature therefore the cable must be buried beneath the level where natural sandwave movement would uncover it. Sometimes this can only be done by removing the mobile sediments before installation takes place.

4.7.8.26 Within both the Offshore Array Area and Offshore ECC geophysical survey data from site specific surveys were used to estimate the sandwave clearance volumes. A corridor of up to 40 m must be cleared per cable circuit. The worst-case design scenario for sandwave clearance is given in **Table 4-15**. The maximum seabed disturbance remains within the limits set out in **Table 4-8**.

Table 4-15 Worst-case Design Scenario – Sandwave Clearance

Component	Within the Offshore Array Area	Within the Offshore Export Cable Corridor
Portion of Area affected by Sandwaves	c. 16 %	c. 16 %
Average Sandwave Height	2 m	4 – 5 m
Sandwave Clearance Impact Width	≤ 40 m	≤ 40 m
Total Spoil Volume from Sandwave Clearance	≤ 1,624,000 m^3	≤ 5,576,000 m^3

Seabed Preparation for Anchor Installation

4.7.8.27 Some form of seabed preparation may be required prior to anchor installation. This may include seabed levelling and removal of surface and subsurface debris such as boulders, lost fishing nets or lost anchors. If debris is present below the seabed, then excavation may be required for access and removal. Maximum spoil volumes are set out in **Table 4-7**.

4.7.8.28 Gravity anchors may need to be placed in pre-prepared areas of seabed. This can involve levelling and dredging of the soft mobile sediments, which would be carried out by dredging vessels using suction hoppers or similar. The spoil would be deposited on site adjacent to the anchor locations. In some cases, it may also be required to place a layer of gravel on the seabed prior to installation of gravity anchors as part of the wider scour protection arrangements, with the required material volumes set out in **Table 4-7**.

4.7.9 Vessel Movements

4.7.9.1 During the construction of the Salamander Project, a number of different vessels will be used for installation, support and transport of equipment and infrastructure to the Offshore Array Area and Offshore ECC. The total vessel numbers and vessel movements are presented in **Table 4-16**. Each vessel movement represents a return trip to and from one of the Salamander Project offshore areas.

4.7.9.2 Indicatively, the busiest period during construction in terms of vessel traffic would be when up to 12 vessels and a support barge could be found in a given 5 km^2 area. This level of activity is unlikely to occur across the entire project area but may be expected to occur simultaneously within two areas of 5 km^2 across the Offshore Array Area and Offshore ECC.

Table 4-16 Worst-case Design Scenario – Construction Vessel Movements

Component	Moorings and Anchors		Subsea Cables		Floating Substructures and WTGs	
	Number of Vessels	*Return Trips*	*Number of Vessels*	*Return Trips*	*Number of Vessels*	*Return Trips*
Jack-Up Vessel	-	-	≤ 1	≤ 2	-	
Heavy Lift Crane Vessel	≤ 1	≤ 14	-	-	≤ 1	≤ 7
Anchor Handling Vessel	≤ 2	≤ 56	≤ 6	≤ 84	≤ 3	≤ 21
Offshore Construction Vessel	≤ 1	≤ 7			≤ 1	≤ 7
Cable Laying Vessel	-	-	≤ 1	≤ 14	-	
Cable Burial / Jointing Vessel	-	-	≤ 1	≤ 14	-	
Shallow Water Cable Barge	-	-	≤ 1	≤ 2		
Support Vessel	≤ 2	≤ 56	≤ 12	≤ 168	≤ 2	≤ 14
Crew Transfer Vessel	-	-	≤ 2	≤ 14	≤ 2	≤ 180
Helicopter	-	-	≤ 1	≤ 14	≤ 1	≤ 7

4.8 Landfall

4.8.1 Landfall Works

4.8.1.1 The offshore export cable(s) will make Landfall east of Lunderton. **Figure 4-20** presents the Salamander Project's landfall compound area of search. As the exact location for landfall has not yet been selected it is not possible to show the onward Onshore ECC and associated work areas such as the proposed landfall compound at this stage.

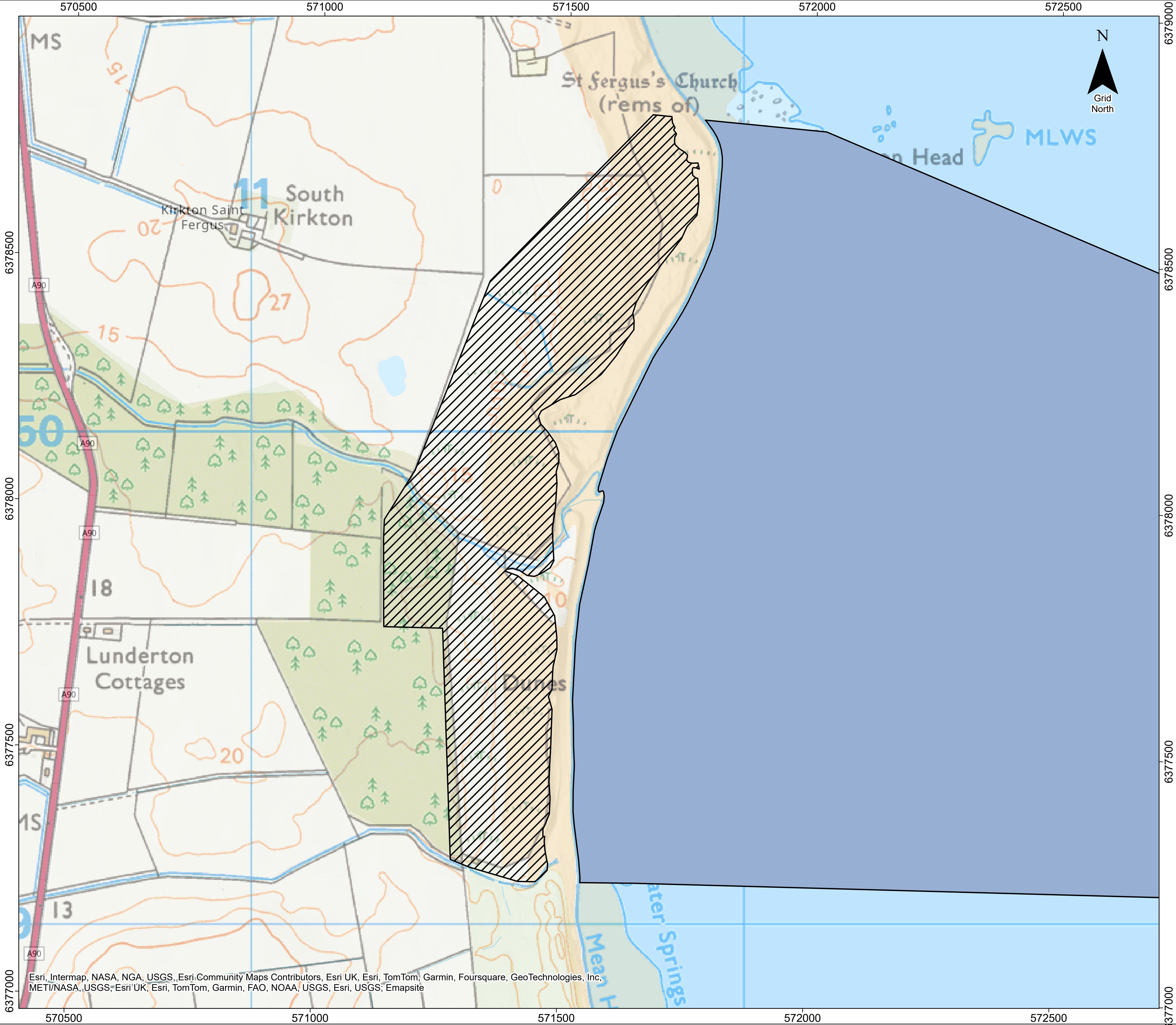
4.8.1.2 Landfall comprises those works required to bring the offshore export cables through the intertidal area to a location where they can be connected to the onshore export cables; this may include:

- Construction of a temporary landfall compound;
- Construction of TJBs;
- Installation of ducts and associated grouting operations;
- Installation of offshore high voltage cables;
- Installation of onshore high voltage cables;
- Backfilling of joint bays; and
- Reinstatement works.

4.8.1.3 The duration of some of the activities forming part of the landfall works is significantly shorter duration than the overall construction window shown in **Figure 4-3**. The duration of landfall works must allow flexibility for these activities to shift within the overall timeframe to account for variables such as weather, the timings of offshore and onshore works reaching Landfall, etc. In addition, the overall duration of works allows for mobilisation and demobilisation of equipment and vessels.

4.8.1.4 The techniques used to carry out the landfall works will be trenchless. Trenchless landfall techniques such as Horizontal Directional Drilling (HDD), Direct Pipe (DP), thrust boring, pipe jacking or other variations where no open trench is used. Trenchless installation allows the subsea cable to transit from the nearshore environment to land, with the remainder of the cable going offshore to be installed using a conventional offshore installation spread. The technical feasibility of this approach would require confirmation via an intrusive geotechnical survey campaign.

4.8.1.5 During landfall works, a temporary landfall compound (up to 15,000 m^2) is required on the onshore side of the intertidal area, landward of the foredunes. This may be used to house the TJB works, the driving trenchless spread, as well as the required supporting equipment and facilities, such as plant storage, consumable storage (including fuel), welfare facilities, parking, pulling winches and anchor points.



Salamander

Figure 4-20

Landfall Compound Area of Search

- Landfall Compound Area of Search
- Offshore Export Cable Corridor

Coordinate System: British National Grid

Scale @ A3 : 1:7,500

0 225 450 Meters

0 250 500 1,000 Feet

Rev	Description	Date
00	Final Issue	16/04/2024
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Doc. Title : Landfall Area of Search
Doc. No : SWF01OR0032
Created by : ES
Checked by : WG
Approved by : MM

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Trenchless Installation

4.8.1.6 Though the method of trenchless installation has not yet been decided, it will involve boring underneath the Intertidal Area using a rig located in the temporary landfall compound above MHWS, as shown in **Figure 4-21**. This allows ducts to be installed under the dunes and beyond the intertidal area into which the offshore export cable(s) can be installed at a later date. The worst-case design scenario for trenchless installation is shown in **Table 4-17**.

4.8.1.7 HDD uses a drilling head controlled from the rig to drill a pilot hole along a predetermined profile to an exit point. This pilot hole is then widened using larger drilling heads until the hole is wide enough to fit the cable ducts. Drilling mud is pumped to the drilling head during the drilling process to stabilise the hole and ensure that it does not collapse.

4.8.1.8 Thrust boring, DP and Pipe Jacking both use a combination of jacking and drilling. An auger with a cutting head is placed inside a steel casing and laid against the wall of an entry pit. The cutting head rotates, drilling the soil and removing the spoils, while a jacking rig pushes or ‘thrusts’ the casing and auger to the exit pit. The DP solution necessitates the excavation of launch shafts onshore but has the benefit of being able to install longer lengths and larger diameters along a steered profile than the other thrust options mentioned, from near surface. In the case of DP, the one pass solution entails installing steel casing to support the bore as it progresses and then would necessitate recovery of a tunnel boring machine (TBM) from the seabed upon advancement. The steel casing/sleeve may be subsequently removed upon installation of high density polyethylene (HDPE) cable ducts within it or remain *in situ*, depending on the viability of removal and also the thermal characteristics of the cable and surrounding ground.

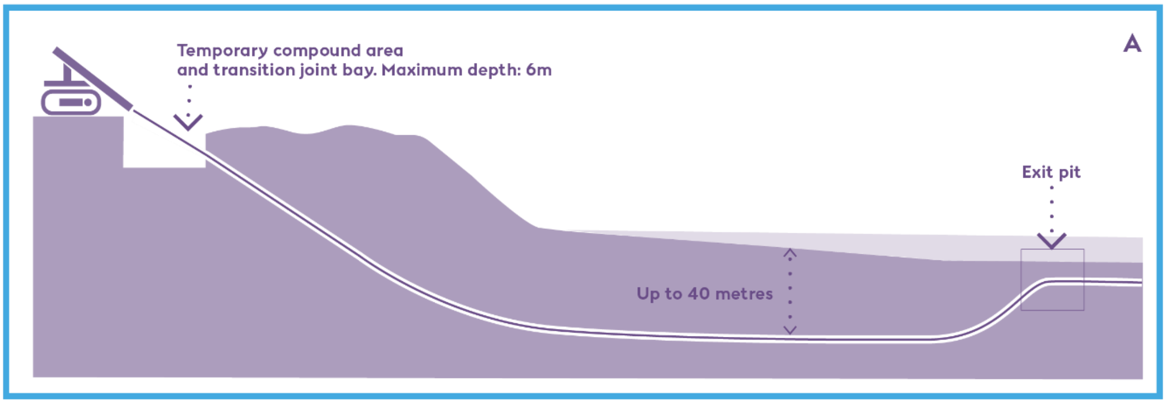

Figure 4-21 Indicative Trenchless Installation Arrangement

4.8.1.9 Depending on the final requirements and method to be used, pits may be dug at both ends of the planned bore to below the level required for the cable, so the rig can carry out the boring horizontally, and the ducts can be installed. Two pits would be required per duct, one on the landward side and one offshore. Given the small tidal range at landfall, a wet punch-out (i.e. an exit below MLWS, no closer than 200 m to MHWS) will occur. The exact length and punch out location would be subject to detailed engineering to ensure vessel accessibility for any trenchless marine support works and also the cable installation can be achieved, amongst other factors. Material from the excavation of the pits would be side cast and left *in situ* and used to backfill the pit after completion and/or left to backfill naturally.

4.8.1.10 The exit pits in the marine environment will be established by either suction dredging, mass flow excavation or conventional excavation depending on the actual soil conditions prevalent and viability of the chosen method, together with other factors such as timeframe between cable installation and completion of the trenchless scope. Where the soil conditions evident do not allow for any form of dredging or excavation, the duct will need to be left exposed on the seabed and secured using rock bags, concrete mattresses or similar. In this scenario, measures will be taken to limit the length of pipe left exposed.

4.8.1.11 Up to two exit pits may be open at the same time. If the pits are dredged, they will be backfilled following cable installation.

4.8.1.12 Overall, exit pit operations will take up to five months per cable, including approximately one month for site setup and exit pit excavation, approximately two months fully open for drilling and duct pull-in, and approximately one month for reinstatement including backfill and removal. In the event that two cable ducts are constructed, some of the above work may occur in parallel, the works for both exit pits will take up to eight months in total. The final timeframe will be dependent on the subsequent cable installation timing, for example, where this is planned consecutively with the trenchless operation, the pit would not be backfilled until post cable installation however, where there is significant time between the two scopes it may be prudent to backfill the duct and then re-expose this at a later date to accommodate the cable installation works. In any case, some trimming of the pits may be required where natural infill occurs between scopes or even during operations to enable the duct and or cable to be successfully buried.

4.8.1.13 Once the boring operations have been completed the ducts (within which the cables will be installed) are pulled through the resulting holes. These ducts are constructed offsite, then sealed and floated to the site by tugs. The ducts are then pulled back through the drilled holes by onshore winches. When the offshore export cables are installed, they are pulled through the pre-installed ducts by onshore winches

Table 4-17 Worst-case Design Scenario – Trenchless Installation

Component	Design Envelope
Number of Trenchless Ducts	≤ 2
Length of Trenchless Ducts	≤ 2,500 m
Diameter of Trenchless Ducts	≤ 1 m
Target Burial Depth of Trenchless Ducts	5 – 40 m
Number of Nearshore Exit Pits	≤ 2
Exit Pit Dimensions (per cable)	≤ 50 x 10 m
Exit Pit Depth (per cable)	≤ 5 m
Total Volume of Material Excavated from Exit Pits	≤ 5,000 m^3

4.8.1.14 Once the ducts have been installed, the pits will likely be temporarily backfilled until the time for cable pull-in. The ducts will then need to be re-exposed (dredged) for a period of up to six weeks to pull in the cables. Grouting operations are then performed prior to final burial of the ducts; these operations will be monitored such that any volume of grout that may be released to the marine environment is expected to be minimal. A small jack-up vessel or flat-topped barge may be required in the shallow water around the exit pits to support cable installation and pull-in activities.

4.8.1.15 Measures for management of drilling slurry would focus on limiting the volume of mud discharged from the punch out of the trenchless operation through various mechanisms to control this. Inevitably during the pull in of the pipe, the drilling mud contained within the bore is displaced by the pipe and some will flow into the marine environment, however the majority will return and be contained onshore. Measures will be enforced to ensure the volume is limited and the composition of the drilling fluid discharged will be chemically inert.

4.9 Operations and Maintenance

4.9.1 Operations and Maintenance Strategy

4.9.1.1 This section provides a description of the reasonably foreseeable O&M activities for the Offshore Development of the Salamander Project. This section of the Project Description will subsequently inform the Operation and Maintenance Programme (OMP) which will be developed post-consent.

4.9.1.2 The Salamander Project will be designed for an anticipated operational life of 35 years, with possible extension should the infrastructure prove to still be in an acceptable condition at the end of this period.

4.9.1.3 The Salamander Project will be operational 24 h a day, 7 days a week.

4.9.1.4 The planned scheduled and routine maintenance of the Salamander Project, for which a licence is required and for which consent is sought, is described in the sections below along with typical unscheduled or reactive maintenance, i.e. the types of faults that offshore wind farms typically experience.

4.9.1.5 Maintenance due to failures that cannot be anticipated are not described here and cannot be included within the application when it is submitted. In addition, some activities outside of standard O&M requirements which may be needed during the Operation and Maintenance phase of the Salamander Project have not been included as it is considered that these would be best considered at a later date once specific details of the requirements are understood.

4.9.1.6 The overall O&M strategy will be finalised once the location of the operation and maintenance base is chosen and the final technical specifications of the Salamander Project are known, including WTG and floating substructure type, electrical export configuration and final project layout.

4.9.1.7 Maintenance activities will be both preventive and corrective, and include activities to inspect, upkeep, repair, adjust, and improve the infrastructure installation, as well as 'like-for-like' replacement, and may include activities to remove, reconstruct and replace. As more knowledge has been gained by the offshore wind industry in O&M over the last years, the industry is developing and improving monitoring and preventive maintenance techniques for operational wind farms.

- Preventive maintenance is carried out in accordance as scheduled services; while
- Corrective maintenance covers unexpected repairs, component replacement, retrofit campaigns and breakdowns.

4.9.1.8 The subsea hub(s) are expected to require minimal or no maintenance throughout the lifetime of the wind farm. Regardless, an annual inspection is expected to be undertaken jointly with the overall inspection schedule for the offshore infrastructure.

Logistics Setup

4.9.1.9 The general offshore O&M strategy may rely on an onshore O&M base, Crew Transport Vessels (CTVs), Service Operation Vessels (SOVs), offshore accommodation, supply vessels, cable and remedial protection vessels and helicopters for the O&M services that will be performed at the Salamander Project. The final O&M strategy chosen may be a combination of the above solutions. The worst-case design parameters for offshore O&M activities are presented in **Table 4-18**. Each vessel movement represents a return trip to and from one of the Salamander Project offshore areas.

4.9.1.10 The vessel movements in **Table 4-18** represent annual averages across the lifetime of the project, and due to the nature of unplanned maintenance, specific years may require more activity than others. During the operational life of the Salamander Project, there will be a maximum of up to 12 O&M vessels in the Offshore Array Area and Offshore ECC on any given day.

Table 4-18 Worst-case Design Scenario – Offshore O&M Movements

Component	Design Envelope
Average Annual SOV or CTV Movements	≤ 190
Average Annual Heavy Lift Vessel Movements (In-Field Maintenance)	≤ 3
Average Annual Towing Spread Movements (Tow-to-Port Maintenance)	≤ 5
Average Annual Anchor Handling Vessel Movements	≤ 12
Average Annual Helicopter Transfers	≤ 140

4.9.2 Wind Turbines and Floating Assembly

4.9.2.1 Once operational, the WTGs and floating substructure form an integrated assembly (referred to here as the floating assembly). The primary means of access will be from vessels, whereby the floating assembly will host one or more access systems (including ladders, walk to work and hoist systems) tailored to certain vessels, or via helicopter.

4.9.2.2 Scheduled inspections and regular maintenance tasks will be performed on site with access to the floating assembly via CTV, helicopter or a walk-to-work SOV vessel within the limits set out in **Table 4-18**. Subsea inspections will be carried out by ROVs or autonomous underwater vessels. An overview of other O&M activities is given in **Table 4-19**.

4.9.2.3 The replacement of major WTG components, for example blades, blade bearings, hub generators, yaw rings or nacelles (like-for-like or within the Project Envelope) may be performed directly on site using a heavy-lift vessel or by using modular/self-installing systems, supported by at least one CTV. One overhaul and one replacement event are expected per floating assembly every five years.

4.9.2.4 Should onsite replacement not be possible, towing to port may be required. The floating substructure, mooring and inter-array / export cable arrangements will be designed to enable the safe and efficient disconnection of the floating assembly from its moored position. The floating assembly will also be designed to allow for towing with conventional tugs between the Offshore Array Area and a suitable port. Anchor-handling vessels may be required for disconnection of the mooring system along with support vessels with work-class ROV for disconnection of the cables. Up to three tugs and an offshore construction vessel may be required during the towing operation.

4.9.2.5 While the floating assembly is offsite, the mooring system and offshore cables will remain *in situ* and their connection to the substructure will be wet-stored on the seabed or connected to a temporary buoy to maintain the connections at the surface for easier reconnection. The location of a stored mooring and / or cable system will be marked by a navigation buoy. Re-connection of the floating assembly after repairs are complete will follow the same process as used during construction.

4.9.2.6 Minor repairs to the floating substructures may include the replacement of access ladders, boat landings and anodes. In addition minor repairs may include modifications to, or corrective maintenance of, the cable outlets and bend stiffeners. This may involve the use of an offshore construction vessel, supported by a CTV, an anchor handling vessel, along with ROVs or divers from a dive support vessel. Up to two events are expected per floating assembly every five years.

4.9.2.7 The floating assembly may require touch up painting during the Salamander Project's operation in order to remain in compliance with marking regulations and maintain the integrity of the asset. Technicians and equipment, largely hand tools, will be deployed from a CTV or similar vessel. Abrasive surface preparation is required to break down existing surface coatings and any associated corrosion. There is expected to be one full paint job per floating assembly every ten years, and one touch-up paint job every three years.

4.9.2.8 Whilst it is expected that the floating substructures will be painted in a low-toxicity anti-fouling paint, marine growth may need to be periodically removed from the floating assembly, likely using a brush or water jet tool. Similarly, bird waste will need to be removed from the WTGs and access points, using a brush to break down the waste (where required) followed by high-pressure jet wash (potable or sea water only). Technicians and equipment will be deployed from a CTV or similar vessel for these activities. Up to five cleaning events per turbine per year are anticipated.

4.9.2.9 Anode replacement or addition work, which is required for corrosion protection, is likely to be undertaken via ROV or divers from a dive support vessel. One anode replacement event is planned per floating assembly every five years.

Table 4-19 Worst-case Design Scenario – Floating Assembly O&M Activities

Component	Design Envelope
Lifetime Scheduled Subsea Inspections (Substructures, Moorings and Cables)	≤ 980
Lifetime Scheduled Major Turbine Overhauls	≤ 50
Lifetime Major Component Replacement	≤ 50
Lifetime Minor Component Repairs or Replacement	≤ 100
Lifetime Turbine / Substructure Repainting	≤ 110
Lifetime Marine Growth / Bird Waste Removal	≤ 1,225
Lifetime Scheduled Anode Additions or Replacement Events	≤ 50

4.9.3 Mooring and Anchors

4.9.3.1 A monitoring, inspection and maintenance plan will be put in place to ensure the integrity of the mooring system. Seabed surveys will be required to ensure that anchors and scour protection remain in place and that the mooring lines remain intact. ROVs and / or geophysical survey methods may be used to monitor the condition of the equipment. An overview of the expected O&M activities is given in **Table 4-20**.

4.9.3.2 The mooring lines may need to be periodically re-tensioned during the lifetime of the wind farm due to stretching and / or anchor creep. Depending on which floating substructure and mooring system is selected, re-tensioning would require either a single anchor handling vessel or an offshore construction vessel and support vessels to provide access. This procedure may be performed up to four times per mooring line during the lifetime of the wind farm.

4.9.3.3 Where anchors or mooring lines need to be replaced, the existing mooring line will be disconnected from the floating assembly and a new line installed and hooked-up to the floating substructure using the same process as used during construction. As the anchor may need to be installed in a new location, new areas of scour protection may need to be installed.

4.9.3.4 Debris, including discarded fishing gear, and marine growth will also be monitored via ROV, with debris and excessive marine growth removed intermittently. As with the floating substructures, some of the mooring system ancillaries[6] may be painted in a low-toxicity anti-fouling paint to reduce the build-up of marine growth. Removal is performed using a work-class ROV deployed from a support vessel. Particularly large or heavy items, such as fishing nets, may require the use of slings and cranes on the vessel for successful removal.

4.9.3.5 Where scour protection had been employed during the initial Construction phase, this may be replenished during operation via the addition of fresh material on top of existing scour protection areas.

Table 4-20 Worst-case Design Scenario – Mooring and Anchors O&M Activities

Component	Design Envelope
Lifetime Mooring Line and Anchor Replacement Events	≤ 40
Total Seabed Impact	≤ 90,000 m^2
Total Spoil Volume (from Drilling / Dredging)	≤ 34,700 m^3
Total Area of New Scour Protection	≤ 84,200 m^2
Total Volume of New Scour Protection	≤ 168,400 m^3
Lifetime Replacement of Existing Scour Protection	≤ 66,575 m^3

4.9.4 Offshore Cables

4.9.4.1 Failure of a cable system would be detected by the wind farm protection and monitoring system. Cable faults may require location testing using remote diagnostic techniques from the OnSS to identify the precise location of a fault along the cable length.

4.9.4.2 Where a fault is detected in a dynamic section of cable, the damaged section of cable will be recovered from the water column and either repaired by splicing in a new section or replaced in its entirety.

4.9.4.3 Where a fault is detected in a buried section of cable, it may be necessary to expose the cable prior to recovery where testing will be conducted to establish the extent and type of repair required. Where cable protection is in place, this would need to be either displaced, in the case of rocks or rock bags, or recovered, in the case of mattresses, prior to recovery of the cable.

4.9.4.4 If the fault takes place in deep water, the cable will be recovered onto the deck of a vessel, the damaged section removed, and a new cable section connected in with two joints. **Figure 4-22** shows the procedure for repairing the cable by replacing the damaged section with the help of splicing. When static cables are replaced on the seabed, one of the joints (the 'inline' joint) is placed in line with the existing cable, the new cable section then forms a repair 'bight' which gives the underwater cable an Ω-shape from where the cable was originally laid. This is necessary when the cable must be taken to a ship for repair as the new section of cable will be longer than the original, meaning that it cannot be placed back in exactly the same place. The cable will be replaced within the licenced boundary for the development.

4.9.4.5 If the fault takes place in shallow water works would be undertaken to excavate the cable using MFE or a dredger. The cable would be recovered onto a platform or jack-up barge, raised above potential high water

[6] Ancillaries may include permanent and temporary buoyancy or clump weights.

levels, to ensure a stable, dry working area for cable repair. The cable would then be cut, and the damaged section replaced. The use of 'inline' joints is preferred, although an 'omega' joint be required in some cases.

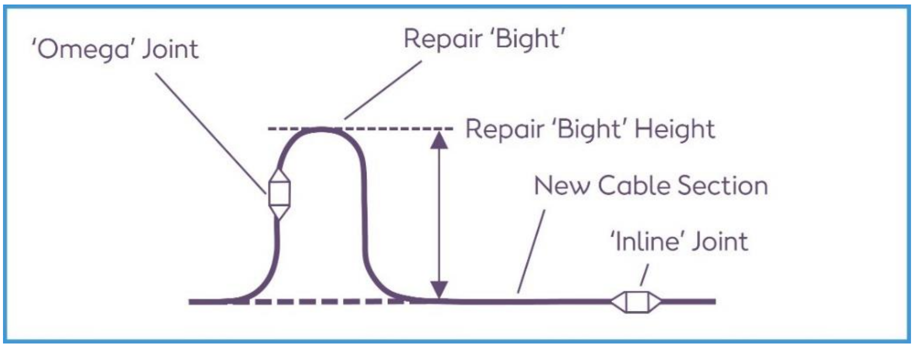

Figure 4-22 Indicative Top-Down View of a Typical Cable Repair

4.9.4.6 After repairs are complete, the cable will again be buried below the seabed using one of the same techniques as used for the initial construction, see **Section 4.7.5** and **Section 4.8.1**. New cable protection material may need to be installed over the repaired section. Upon completion of re-burial, a post-burial survey will be carried out to assess whether the cable is at the correct position and required depth of lowering.

4.9.4.7 Seabed surveys will also be required to ensure that cables remain buried and that the scour protection around cable crossings remains intact. Typically, this will be undertaken more frequently in early years, hence this assessment is based on twice yearly for first three years; followed by yearly thereafter. These surveys may include geophysical surveys using hull mounted or towed equipment as well as visual inspections using ROVs.

4.9.4.8 Remedial burial of cable sections may be necessary in areas that may become exposed via natural sediment transport processes. Cable data will be reviewed to identify priority areas possibly requiring remediation. A multibeam sonar (or similar) will then be used to confirm the location and current cable depth of lowering and/or areas of exposure. Should any areas of exposed or insufficiently buried cables be identified, jetting equipment (i.e. MFE or similar) operated from a vessel, or diver operated injector, will be powered up and manoeuvred along the exposed cable at a steady rate until the desired depth of lowering is achieved. Once complete, a seabed survey will be conducted to determine the success of the operation. If necessary, another pass may be required to achieve the specified depth.

4.9.4.9 Where rock protection has been employed for cable protection during the initial Construction phase, this may be replenished during operation via the addition of fresh material on top of existing cable protection areas. **Table 4-21** presents the worst-case parameters for cable repair and replacement events, including the volume of additional protection that may be required.

4.9.4.10 Debris, including discarded fishing gear, and marine growth will also be monitored via ROV, with debris removed intermittently. As with the floating substructures, the offshore cables and ancillaries[7] may be painted in a low-toxicity anti-fouling paint to reduce the build-up of marine growth. Removal is performed using a work-class ROV deployed from a support vessel. Particularly large or heavy items, such as fishing nets, may require the use of slings and cranes on the vessel for successful removal.

[7] Ancillaries may include permanent and temporary buoyancy, bend stiffeners/restrictors, tether clamps, clump weights or touchdown protection.

Table 4-21 Worst-case Design Scenario – Offshore Cable O&M Activities

Component	Within the Offshore Array Area	Within the Offshore Export Cable Corridor
Lifetime Subsea Cable Repair and Replacement Events	≤ 8	≤ 6
Lifetime Subsea Cable Reburial	≤ 3.9 km	≤ 3.5 km
Total Seabed Impact from Repair and Reburial	≤ 774,000 m^2	≤ 694,000 m^2
Total Intertidal Impact from Repair and Reburial	0	≤ 42,000 m^2
Total Seabed Impact from Repair Vessel Anchors	≤ 8,000 m^2	≤ 8,800 m^2
Total Spoil Volume from Cable Reburial	≤ 29,000 m^3	≤ 26,000 m^3
Total Area of New Cable Protection	≤ 12,000 m^2	≤ 24,000 m^2
Total Volume of New Cable Protection	≤ 12,375 m^3	≤ 15,000 m^3
Lifetime Cable Protection Replacement	≤ 11,400 m^3	≤ 21,000 m^3

4.9.5 Offshore Surveys

4.9.5.1 Offshore surveys will be needed on an ongoing basis throughout the O&M phase, including geophysical surveys to monitor the condition of the seabed and subsea infrastructure, depth of burial surveys using acoustic or electromagnetic survey techniques to monitor the condition of buried cables, and visual inspections via ROV, as described in the relevant sections above.

4.9.5.2 Full wind farm surveys will also typically be performed, with the first taking place within the first year after commissioning, between the first and second winter storm seasons, with a view to monitoring the condition of the infrastructure after this period. A follow-up survey is then typically performed between the second and fourth winter storm periods.

4.9.5.3 In order to observe longer term seabed changes and the adaption of the seabed to the presence of scour protection, a third wind farm survey is typically performed between the fifth and eighth year from the start of operations.

4.9.5.4 The survey schedule for the remaining lifetime of the wind farm will be determined after the first three surveys. This schedule should include, as a minimum, two further surveys over the remaining lifetime of the wind farm. Depending on site conditions, additional or rescheduled monitoring following a major storm event, typically a >10 year event, may be carried out.

4.9.6 Electromagnetic Fields

4.9.6.1 The electrical transmission infrastructure will generate electric and magnetic fields (EMFs) when in operation. HVAC infrastructure generates EMFs principally at 50 Hertz (Hz); these are often referred to as power frequency, or extremely low frequency (ELF), EMFs. These EMFs are produced wherever electricity is generated, transmitted or used.

4.9.6.2 The Salamander Project has modelled the expected EMF levels from the offshore export and inter-array cables, based on the worst-case assumption of a 3-core submarine cable with 630 mm^2 copper conductors operating at 66 kV and 880 A. Electrical fields stemming from the cable conductors are completely shielded by the solidly bonded screens, while the magnetic fields in the vicinity of the stranded 3-core cables are calculated using industry-standard methodology, based on the lay length of the power cores, the distance between power cores and the phase current loadings of the conductors.

4.9.6.3 For dynamic cables in the water column, the magnetic field drops rapidly from c. 850 microtesla (µT) at the cable surface to c. 55 µT once a distance of 25 cm is reached, decreasing further to below 1 µT at a distance of <1.25 m from the cable, as shown in **Figure 4-23**.

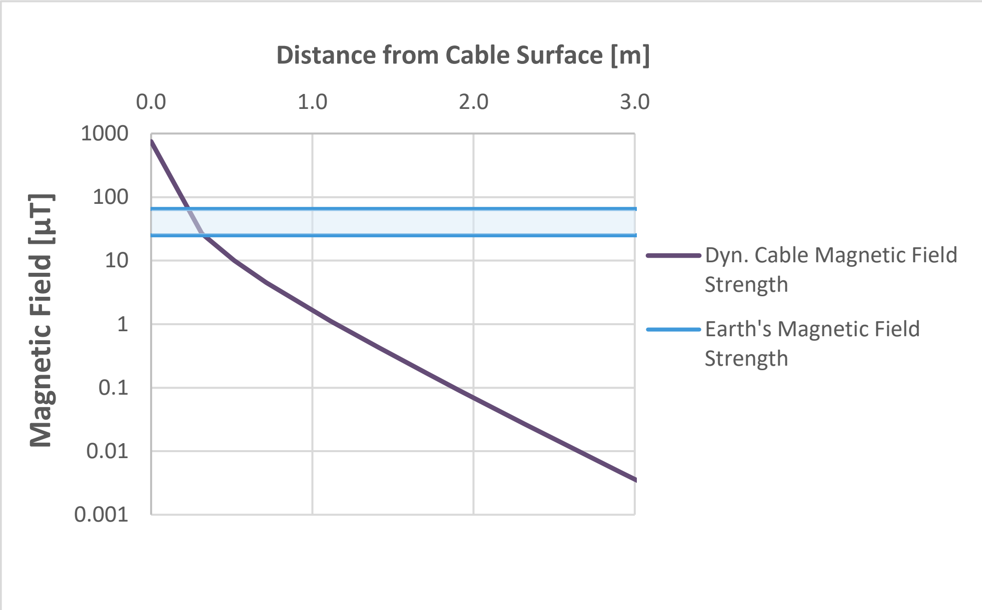

Figure 4-23 Magnetic Field for 66 kV Cables in the Water Column

4.9.6.4 For buried cables, the magnetic field at the seabed depends on the depth of lowering, as shown in **Figure 4-24**. The peak magnetic field at the seabed drops from c. 16 µT with 0.5 m of burial cover to c. 2 µT when buried to 1 m, decreasing further to c. 0.1 µT when buried to 2 m. Static cable depths of lowering at the Salamander Project are expected to be in the range of 0.6 – 2 m, where technically feasible; the final target depth will be determined post consent and will be based on the CBRA (see **Section 4.7.5**).

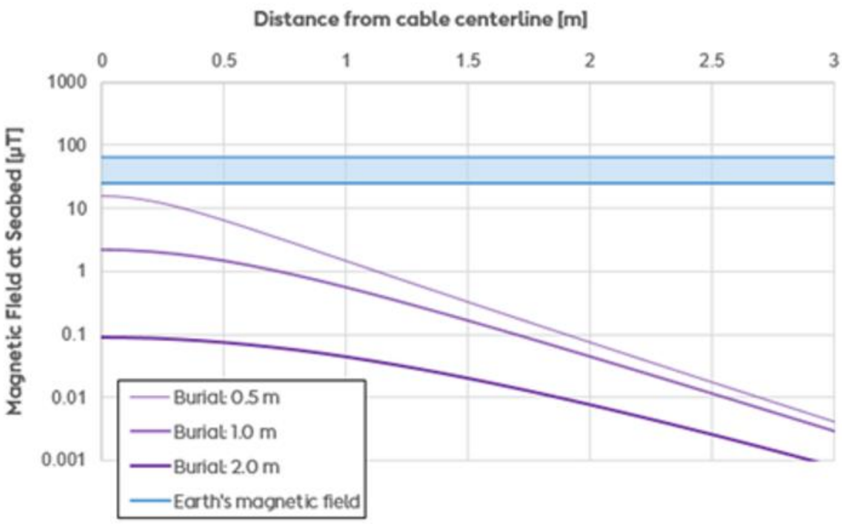

Figure 4-24 Magnetic Field at the Seabed for Buried 66 kV Cables

4.9.7 General Practices

Security

4.9.7.1 The Salamander Project will be suitably secured throughout all phases of operation to ensure those working onsite can work in safety and the supply of electricity to the National Grid remains secure.

4.9.7.2 Any above ground onshore infrastructure such as the OnSS will be housed in secure gated compounds, as will any ongoing construction work. The offshore infrastructure is by nature inaccessible due to being situated offshore.

Health and Safety

4.9.7.3 All elements of the Salamander Project will be risk assessed according to the relevant government guidance as well as internal best practice. These risk assessments will then form the basis of the methods and safety mitigations put in place across the life of the Salamander Project.

4.9.7.4 The Salamander Project has a focus on employee safety and has Quality, Health, Safety and Environment (QHSE) policies in place to ensure that the wind farm is safe by design and that processes and procedures are adhered to. There is a clearly defined safety culture in place in order to avoid incidents and accidents.

4.9.7.5 There will be constant controls to ensure that the safety measures are observed and followed and that the Salamander Project has built a safe workplace for its employees and contractors, which include the roll out and implementation of the new Ørsted Safety survival rules.

4.9.7.6 The focus on QHSE is intended to ensure that everyone feels safe, in a highly controlled and safety-driven environment. This is the Salamander Project's first priority. It is done by closely monitoring all matters relating to health and safety.

Climate Change and Natural Disasters

4.9.7.7 The above ground/seabed components, such as the WTGs, OnSS and EBI are designed and constructed with materials considered resilient to climate change effects. The onshore and offshore electrical cables will be buried underground, where technically feasible. This provides protection from climate change effects for the duration of the Operation and Maintenance phase and resilience to flood or other extreme weather events. The Salamander Project is expected to be resilient to climate change over its 35-year operational design life; further details and assessment of impacts are provided in **Volume ER.A.3, Chapter 20: Climate Change and Carbon** and **Volume ER.A.3, Chapter 21: Major Accidents and Disasters.**

4.10 Decommissioning

4.10.1 Decommissioning Strategy

4.10.1.1 In line with the Scottish Government's position on the decommissioning of OREI, at the end of the operational lifetime of the Salamander Project, it is anticipated that all structures above the seabed or ground level will be completely removed. The Energy Act 2004 require that a Decommissioning Programme must be submitted to MD-LOT for consultation and approval by the Scottish Ministers, a draft of which would be submitted prior to the construction of the Salamander Project, supported by appropriate financial security. The Decommissioning Programme will be updated during the Salamander Project's lifespan to take account of changing best practice and new technologies. The approach employed at decommissioning will be compliant with the legislation and policy requirements at the time of decommissioning.

4.10.1.2 The overarching principles that will be followed when developing an appropriate Decommissioning Programme are derived from Marine Scotland's Guidance Note (The Scottish Government, 2022b), and will consider:

- Environmental impacts;
- Safety of surface and subsurface navigation;
- Other uses of the sea; and
- Health and safety considerations.

4.10.1.3 The Applicant is committed to restoring the Offshore Development Area, as far as is reasonably practicable, to the condition that it was in prior to construction. In line with the details provided above, The Applicant is also committed to ensuring the Offshore Development is safely and effectively decommissioned.

4.10.1.4 A range of surveys will be conducted both before decommissioning begins, to determine the condition of the infrastructure and allow effective planning of activities, and post decommissioning to verify the final condition of the site and confirm that all requirements have been met. This may include geophysical surveys, depth of burial surveys using acoustic or electromagnetic survey techniques and visual inspections via ROV.

4.10.2 Offshore Infrastructure

4.10.2.1 The decommissioning sequence will generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment. The total vessel numbers and vessel movements are presented in **Table 4-22**. Each vessel movement represents a return trip to and from one of the Salamander Project offshore areas.

4.10.2.2 Indicatively, the busiest period during decommissioning in terms of vessel traffic would be when up to 12 vessels and a support barge could be found in a given 5 km^2 area, either within the Offshore Array Area or the Offshore Export Cable Corridor.

Table 4-22 Worst-case Design Scenario – Decommissioning Vessel Movements

Component	Decommissioning	
	Number of Vessels	*Return Trips*
Heavy Lift Vessels	≤ 1	≤ 21
Anchor Handling Vessels	≤ 6	≤ 77
Support Vessels	≤ 12	≤ 238
Crew Transfer Vessels	≤ 2	≤ 180
Helicopters	-	≤ 14

Wind Turbines and Floating Assembly (including Moorings and Anchors)

4.10.2.3 The wind turbines and floating substructures will be disconnected from their moorings and towed to port for disassembly, recovery and recycling. The mooring lines and anchors will be recovered and removed from site.

4.10.2.4 Where piled anchors have been used these would likely be cut approximately 1 m below the seabed, with due consideration made of likely changes in seabed level and only the upper section removed. At this point in time, it is not thought to be reasonably practicable to remove entire piles from the seabed, but endeavours will be made to ensure that the sections of pile that remain in the seabed are fully buried. The details of pile removal would be consulted on and agreed nearer the time of decommissioning, and any application would be supported by a comparative assessment process and a suitable body of evidence.

4.10.2.5 Any scour protection is intended to be left *in situ*. If scour protection is to be removed using currently available technology, it would most likely be removed by a vessel using a dredger or grab.

Offshore Cables

4.10.2.6 The dynamic portion of the array cables (i.e. the portion suspended in the water column) will be detached from the floating substructures and either be cut or disconnected close to the touch-down point or hub in order to recover the cable and remove it from site.

4.10.2.7 To remove the buried cables, it is likely that equipment similar to that which was used to install the cables could be used to reverse the burial process and expose them. Therefore, the area of seabed impacted during the removal of the cables could be the same as the area impacted during the installation of the cables. Once the cables are exposed, a grapnel or similar would be used to pull the cables onto the decks of cable removal vessels. The cables would be cut into manageable lengths and returned to shore. Divers and/or ROVs may be used to support the cable removal vessels. Once onshore, it is likely that the cables would be deconstructed to recover and recycle the copper, aluminium and/or steel within them.

4.10.2.8 Should full cable removal not be desired, an alternative option is to leave cables buried in place with the cable ends cut, sealed and securely buried as a precautionary measure. The final approach would be agreed with relevant stakeholders in line with guidance at the time of the decommissioning works.

4.10.2.9 The current intention is that offshore cable rock protection will be left *in situ*. If rock protection is to be removed using currently available technology, it would most likely be removed by a vessel using a dredger or grab.

4.11 Marking, Lighting and Safety Zones

4.11.1 Aids to Navigation and Marking

4.11.1.1 All surface infrastructure, including any required aids to navigation, will be designed in accordance with relevant guidance from the NLB, the CAA and the Maritime and Coastguard Agency (MCA). This will include colours, marking and lighting. The positions of all infrastructure will be conveyed to the UKHO so that they can be incorporated into Admiralty Charts and the NtM procedures.

4.11.1.2 Lighting and marking of subsea structures will be discussed with the NLB, having a statutory duty as a General Lighthouse Authority, where there may be a risk to shipping. In this case, the marking would be based on the recommendations of the International Association of Marine Aids to Navigation and Lighthouse Authorities and the applicable requirements of the MCA's Marine Guidance Note 654.

4.11.1.3 The specific requirements for marking and lighting the Offshore Development will be determined post-consent in consultation with the relevant stakeholders. A Lighting and Marking Plan (LMP) will be developed and submitted to MD-LOT for consultation and approval by the Scottish Ministers prior to the start of construction.

4.11.2 Safety Zones

4.11.2.1 In accordance with the Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007 (UK Parliament, 2007), the Salamander Project expects to apply for 500 m safety zones around each renewable energy installation during the construction or decommissioning periods under Section 95 of the Energy Act 2004 (UK Parliament, 2004) due to the restricted ability for vessels to manoeuvre in the vicinity of ongoing works. Section 62 of the Scotland Act 2016 (Scottish Parliament, 2016) amends Section 95 of the Energy Act 2004 making Scottish Ministers the appropriate Minister for safety zones.

4.11.2.2 To minimise disruption to navigation by users of the sea during construction (and decommissioning)[8] activity, the safety zones are likely to be phased and therefore active only on the infrastructure that is currently under construction (or decommissioning). Additionally, it is expected that 50 m safety zones will be applied for around all incomplete renewable energy installation at which construction (or decommissioning) activity may be temporarily paused (and therefore the 500 m safety zone has lapsed) or where construction (or decommissioning) works are completed but the infrastructure has not yet been commissioned (or decommissioned).

4.11.2.3 As legal safety zones can only be established around the outer edge at sea level of an Offshore renewable energy installation (OREI), rather than a vessel, it is standard safe working practice to establish advisory safe passing distances (generally 500 m) around installation and decommissioning vessels, e.g. around cable installation vessels as they move along the cable route. This is to protect both the construction vessels and other vessels using the surrounding area, especially where installation vessels are deploying larger anchor spreads. NtMs would be issued suggesting these advisory safe passing distances in respect of the offshore installation and decommissioning works.

4.11.2.4 During the O&M phase when there are periods of major maintenance works being undertaken where there is a potential risk to other marine users or project operations and maintenance vessels or staff, temporary 500 m safety zones will be applied for under the Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.

[8] Whilst it is likely that similar safety zones will be needed for decommissioning, the details are not known at this stage; requirements for safety zones for decommissioning will be confirmed closer to the point of decommissioning at the end of the Salamander Project lifetime.

4.12 References

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