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Offshore Substation General Requirements Functional Specification

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1 ABBREVIATIONS

Abbreviation	Definition
AC	Alternating current
AHU	Air Handling Unit
AIS	Automatic identification system
ALARP	As low as responsible
AOPS	Automatic Overload Protection System
APAC	Asia pacific countries
ATEX	Atmospheres Explosible
ATP	Airtight platform
CAPEX	Capital Expenditure
CCTV	Closed Circuit Tele Vision
CoG	Centre of Gravity
CSA	Cross Sectional Area (used with reference to cross section of conductor in high voltage cable applications).
CT	Current transformers
CTV	Crew Transfer Vessel
DC	Direct current
DCC	Distribution Control Centre
DECC	(Irish) Department of the Environment, Climate and Communications
DECOMEX	Decommissioning Expenditure
DN	Diamètre Nominal
DNVGL	Det Norske Veritas and Germanischer Lloyd
ECC	Emergency Control Centre
EEA	European economic area
EERA	Escape, Evacuation and Rescue Analysis
EHV	Extra High Voltage (220kV and above), mainly used for transmission voltages in the context of this document
EMC	Electromagnetic compatibility
EMP	Environmental management plan
ERP	Emergency response plan
EU	European Union
FCU	Fan Coil Unit

Abbreviation	Definition
FEED	Front end engineering and design
FEED	Front end engineering and design
FERA	Fire and explosion risk analysis
FMECA	Failure modes, effects, and criticality analysis
FSD	Functional specification document
GBP	Grid connection point
GCA	Grid connection agreement
GCS	Grid connection system
GIS	Gas Insulated Switchgear
HAT	Highest Astronomical Tide
HazOp	Hazard operability (study)
HEMS	Helicopter emergency medical service (rescue helicopter)
HSA	(Irish) Health and Safety Authority
HSE	Health Safety and Environment
HSF	Health and safety file
HTA	Hierarchical task analysis
HV	High Voltage, for the purposes of the offshore standards this is assumed to be the array voltage of typically 66 kV
HV/AC	Heating, Ventilation and Air-Conditioning
I.S.	Irish Standard (Organisation)
IAC	Inter array cables (by ORED)
IBC	Intermediate bulk container
ICCP	Impressed Current Cathodic Protection ICCP
IEC	International Electrotechnical Commission
IMP	Interface Management Plan
IPP	Independent Power Producer
ISO	International Organisation for Standardisation
ITP	Inspection and test plan
JUV	Jack-Up Vessel
JV	Joint venture
kV	Kilovolt
LAN	Local area network
LAT	Lowest Astronomical Tide
LIDAR	Light detection and ranging

Abbreviation	Definition
LoP	List of open points
LSA	Life saving appliances
LV	Low Voltage
MAL	Maintenance Activity List
MAP	Marine area planning
MCG	Motion compensated gangway (for W2W access and egress)
MDR	Master document register
MEDEVAC	Medical evacuation
Met station	Meteorological station
MHS	Material handling study
MOB	Man over board
MOC	Management of change
MSL	Mean Sea Level
MTTF	Mean Time to Failure
MTTR	Mean Time to Repair
MV	Medium voltage
NCC	National Control Centre by TSO
O&G	Oil and gas
O&M	Operations and maintenance
OCC	Onshore Compensation Compound
OPEX	Operational Expenditure
ORED	Offshore renewable energy developer
OREI	Offshore Renewable Energy Installation
OSP	Offshore substation platform
OSV	Offshore supply vessel
OWF	Offshore windfarm
PAGA	Public Address General Alarm
PCC	Point of Common Coupling
PH	Period hours
POB	Person on board (substation)
POC	Point Of Connection
PPE	Personal protective equipment
PSV	Platform Supply Vessel
QC	Quality control

Abbreviation	Definition
QMP	Quality Management Plan
RAM	Reliability, availability and maintainability
RAM(S)	Reliability, Availability, Maintainability and expanded to Safety by Design
RAMS	Acronym for combined risk assessment and method statement
RCM	Reliability Centred Maintenance
rms	Root-mean-square
SCADA	Supervisory, Control & Data Acquisition
SE	Systems engineering
SI	Statutory instrument
SLD	Single Line Diagram
SME	Subject matter expert
SOV	Service operation vessel
SRL	Self-retracting line
SWL	Save Working Load
T&I	Transport and Installation
TAO	Transmission Asset Owner
TSO	Transmission System Operator
UK	United Kingdom
UPS	Uninterruptible Power Supply
US	United States
UTM	Universal Transverse Mercator (Coordinate System)
UV	Ultraviolet
VT	Voltage transformers
W2W	Walk to Work (motion compensated gangway system)
WTG	Wind turbine generator

2 INTRODUCTION

This document replaces EirGrid's functional specification for offshore substations ODS-GFS-00-001 from 2018.

This Functional Specification is applicable for offshore wind transmission assets delivered by the Customer as Contestable Works, to be owned and operated by EirGrid.

This document outlines the general requirements for the design, fabrication, installation and commissioning, including trial operations and handover, of Offshore Substation Platforms (OSP), including foundation, support structure, topside structure, platform systems and sub-systems.

References are made to supporting specifications for components, systems and activities associated with the OSP. Specifications relating to the OSP are as follows:

Table 1: EirGrid Specifications relating to the OSP

Document Number	Document Title
OFS-OSP-130	OSP General Specification
OFS-OSP-135	OSP Primary Electrical System Specification
OFS-OSP-136	OSP Auxiliary Electrical System Specification

The above specifications directly applicable to the OSP should be read in conjunction with the following:

- XDS-SDM-00-001 Safe by Design Methodology
- OFS-GEN-024 Guidance for derogation requests
- OFS-GEN-012 Review & Oversight Procedure (Guidance document)
- OFS-GEN-005 Guidance for Network Engineering Studies (Guidance document)
- OFS-GEN-004 Certification and Verification Requirements
- OFS-GEN-006 Documentation, Drawings, Coding and Nomenclature General Specification
- OFS-GEN-009 Operation & Maintenance General Specification
- OFS-GEN-015 Functional Specification SCADA and Telecommunications
- OFS-GEN-016 Functional Specification Control & Protection and Metering

In addition to the above, this specification should be read in association with the project specific contestable works pack and project documentation and all other relevant functional specifications as issued by EirGrid.

Customer Array System Switchgear and associated control and protection systems are not covered by this specification but is to be specified by the Customer.

For the purpose of this specification the term Customer shall refer to Offshore Wind Power Developers, Independent Power Producers responsible for the design and build of assets to be handed over to EirGrid.

EirGrid's aim is for this specification to be functional, with stated preferences in certain areas to allow for some level of commonality and economies of scale across assets to reduce the operational costs associated with these assets.

3 Governing Standards

The standards set out in this specification and associated specifications referenced herein define the minimum requirements and shall be without prejudice to any higher standard, codes and practice. It shall be the responsibility of the Customer to propose a solution that not only meets the basic requirements of the standards but is fit for the purpose and the circumstances in which it is used.

Unless noted to the contrary, all platform systems, equipment, materials and labour shall be supplied, designed and constructed in accordance with the applicable sections of the latest revisions of standards.

The Customer shall take account of emerging changes in standards, regulations and codes of practice and ensure that these are included in the design, supply, installation, testing and commissioning, energisation and trial period of the entire offshore substation.

Customer is to pay due consideration to the emerging and latest legislation and regulation with respect to health and safety regime pertaining to offshore renewables.

3.1 Hierarchy of Laws, Standards and Regulations

Hierarchy of applicable standards, legislation and generally recognised codes of practice for the fabrication and outfitting may overlap in some areas or need to be complemented in specific areas. It is the responsibility of the Customer to ensure there are no gaps or discrepancies between applied standards.

The hierarchy of legislation, regulation and codes of practice is shown in Figure 1, serving as an example only. In principle, legal regulations take precedence over all others.

Standards or rules higher in the hierarchy always govern the design requirements. Where rules or standards are not sufficiently specific, they can be supported by a standard lower in the hierarchy.

This general hierarchy can deviate for systems if subordinate regulations imply a higher standard.

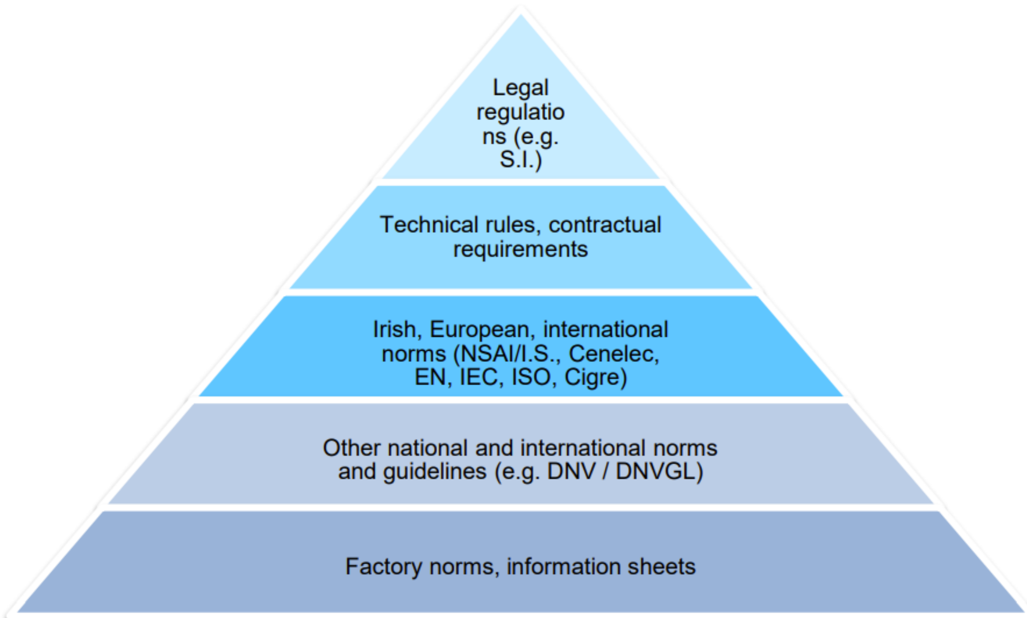

Figure 1: Example hierarchy of legislation, regulation, and codes of practice.

3.2 Recognised Industrial and Offshore Standards

Except where otherwise stated in EirGrid's specifications, the OSP shall be designed, manufactured, commissioned, tested and installed according to the latest edition of the standards, specifications and codes outlined in this document in addition to the specifications listed in Section 2. Normative references and linked standards mentioned in these shall be respected. The use of draft standards is not permitted without the specific permission of EirGrid.

The Customer shall state the codes of practice proposed for any item of plant, system or equipment not covered by a standard. The Customer shall submit two (2) English language copies of these standards.

The governing standard for design that will be adopted is Det Norske Veritas (DNV) Standard DNV-ST-0145 "Offshore substations".

Standards appropriate to offshore installations shall be applied; standards derived for onshore application shall not be employed unless specifically approved for use by EirGrid.

Any proposed departures from these standards must be agreed with EirGrid.

3.2.1 Structural Design

Table 3-1 Industrial and Offshore Specific Standards and Guidelines, Structural Design

Document Number	Document Title
DNV-ST-0145	Offshore substations
N/A	DNV Rules for Planning and Execution of Marine Operations.
DNV-OS-C101	Design of offshore steel Structures LRFD
DNV-OS-C502	Offshore Concrete Structures (if applicable)
DNV-ST-N001	Marine operations and marine warranty
DNV-RP-B401	Cathodic protection design
DNV-RP-C203	Fatigue design of offshore steel structures
DNV-RP-C204	Design against accidental loads
DNV-RP-C205	Environmental conditions and environmental loads
DNV-RP-C208	Determination of structural capacity by non-linear finite element analysis methods
DNV-ST-0126	Support structures for wind turbines
DNV-ST-0378	Offshore and platform lifting appliances
DNV-ST-0437	Loads and site conditions for wind turbines
EN ISO 19901-1	Petroleum and natural gas industries — Specific requirements for offshore structures — Part 1: Metocean design and operating considerations
EN ISO 19901-3	Petroleum and natural gas industries — Specific requirements for offshore structures — Part 3: Topside structure
EN ISO 19901-5	Petroleum and natural gas industries — Specific requirements for offshore structures — Part 5: Weight control during engineering and construction
EN ISO 19902	Petroleum and natural gas industries — Fixed steel offshore structures
ICAO Doc 9261	Heliport Manual
ISO-14122	Safety of Machinery. Permanent means of access to machinery. (All parts)
EN 1090	Steel structures and aluminium structures (all parts where applicable)

3.2.2 Materials

Table 3-2 Industrial and Offshore Specific Standards and Guidelines, Materials

Document Number	Document Title
DNV-OS-B101	Metallic materials
DNV-OS-C401	Fabrication and testing of offshore structures
EN 10204	Metallic products - Types of inspection documents
EN 10255	Non-alloy Steel Tubes for Welding and Threading
EN 10164	Steel products with improved deformation properties perpendicular to the surface of the product

3.2.3 Corrosion Protection

Table 3-3 Industrial and Offshore Specific Standards and Guidelines, Corrosion Protection

Document Number	Document Title
EN ISO 12944-1	Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 1: General introduction
EN ISO 12944-2	Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 2: Classification of environments
EN ISO 12944-3	Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 3: Design considerations
EN ISO 12944-4	Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 4: Types of surfaces and surface preparation
EN ISO 12944-5	Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 5: Protective paint systems
EN ISO 12944-6	Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 6: Laboratory performance test methods
EN ISO 12944-7	Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 7: Execution and supervision of paint work
EN ISO 12944-8	Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 8: Development of specifications for new work and maintenance
EN ISO 12944-9	Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 9: Protective paint systems and laboratory performance test methods for offshore and related structures
EN 12495	Cathodic protection for fixed steel offshore structures
EN 12496	Galvanic anodes for cathodic protection in seawater and saline mud
NORSOK M-501	Surface preparation and protective coating

3.2.4 Electrical Systems

See OFS-OSP-135 and OFS-OSP-136.

3.2.5 Platform Support Systems

Table 3-4 Industrial and Offshore Specific Standards, Guidelines and References

Document Number	Document Title
DNV-OS-D201	Offshore Standards – Electrical installations
DNV-OS-D202	Automation, safety, and telecommunication systems
DIN EN 16798-3	Energy performance of buildings - Ventilation for buildings - Part 3: For non-residential buildings - Performance requirements for ventilation and room-conditioning systems
EN 1505	Ventilation for buildings - Sheet metal air ducts and fittings with rectangular cross section - Dimensions
EN 1506	Ventilation for buildings - Sheet metal air ducts and fittings with circular cross-section - Dimensions
EN 1838	Lighting applications. Emergency lighting
EN 12464-1	Light and lighting. Lighting of workplaces - Indoor workplaces
EN 12464-2	Light and lighting. Lighting of workplaces - Outdoor workplaces
EN 61078:2016	Reliability block diagrams
IEC 60331 Series	Tests for electric cables under fire conditions – Circuit integrity
IEC 60332 Series	Tests on electric and optical fibre cables under fire conditions
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60812:2018	Failure modes and effects analysis (FMEA and FMECA)
IEC 61892-2	Mobile and fixed offshore units – Electrical installations – Part2: System design
IEC 62034	Automatic test systems for battery powered emergency escape lighting
ISO 14694	Industrial fans — Specifications for balance quality and vibration levels
ISO 21940-11	Mechanical vibration — Rotor balancing — Part 11: Procedures and tolerances for rotors with rigid behaviour
NORSOK S-002	Working environment
Marpol 73/78	International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978
PED 2014/68/EU	Pressure Equipment Directive
IMO FTP Code 2010	INTERNATIONAL CODE FOR APPLICATION OF FIRE TEST PROCEDURES, 2010 with amendments from 2018

Document Number	Document Title
EN 13852	General-purpose offshore cranes
ASHRAE	American Society of Heating, Refrigerating, & Air Conditioning Engineers – Codes and Standards for HVAC
ISO 7547	Shipbuilding – Air-conditioning and ventilation of accommodation spaces on board ships – Design conditions and basis of calculations.
ISO 8861	Shipbuilding – Engine room ventilation in diesel-engine ships – Design requirements and basis of calculations
ISO 8862	Air-conditioning and ventilation of machinery control rooms on board ships – Design conditions and basis of calculations
ISO 9943	Shipbuilding – Ventilation and air treatment of galleys and pantries with cooking appliances
NORSOK H-001	Heating, Ventilation and Air-Conditioning (Note-1)
EN 60079-10	Explosive atmospheres. Classification of areas. Explosive gas atmospheres
NORSOK H-003	HVAC and Sanitary Systems (Note-1)
ISO 15138	Petroleum and natural gas industries - Offshore production installations. Heating, ventilation, and air-conditioning (Note 1)
EN 50272-2	Safety requirements for secondary batteries and battery installations. Stationary batteries
DW 144	Specification for sheet metal ductwork
Notes: 1 shall be applied for general guidelines, whereby items relating specifically to an oil and gas platform and oil and gas production related risks do not have to be followed.)	

3.2.6 Safety and Reliability and Maintainability

Table 3-5 Safety and reliability standards and guidelines

Document Number	Document Title
EN 13849	Safety of machinery — Safety-related parts of control systems
IEC 61508	Functional safety of electrical/electronic/programmable electronic safety-related systems
IEC 61078	Analysis techniques for dependability - Reliability block diagram and Boolean methods
IEC 61511	Functional safety - Safety instrumented systems for the process industry sector
ISO 17776	Petroleum and natural gas industries — Offshore production installations — Major accident hazard management during the design of new installations
IEC 62061	Safety of machinery - Functional safety of safety-related electrical, electronic, and programmable electronic control systems
ISO 14122-2	Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways

Document Number	Document Title
ISO 15544	Petroleum And Natural Gas Industries -Offshore Production Installations-Requirements And Guidelines For Emergency Response
IEC 61025	Fault tree analysis (FTA)
2006/42/EC	Machinery Directive
SOLAS 74/88	SOLAS - International Convention for the Safety of Life at Sea
EN 13306	Maintenance — Maintenance terminology
EN 60300-3-12	Dependability management — Part 3-1. 2Application guide - Integrated logistic support
IEC 60300-3-14	Dependability management — Part 3-14: Application guide - Maintenance and maintenance support
IEC 60706-2	Guide on maintainability of equipment. Part 2 - Section Five: Maintainability studies during the design phase
IEC 60300-3-11	Dependability management — Part 3-11: Application guide - Reliability centred maintenance
RCM II	“Reliability Centred Maintenance” of Moubray, first published in 1991
IEC 60812	Analysis techniques for system reliability — Procedure for failure mode and effects analysis (FMEA)
IEC 61882:2002	Hazard and operability studies (HazOp studies) - Application Guide.
CAP 437	Standards for Offshore Helicopter Landing Areas) produced by the Civil Aviation Authority (UK)
-	UK Energy Institute’s good practice guidelines for safe helicopter operations in support of the global offshore wind industry parts A and B
-	UK Energy Institute’s G+ “good practice guideline document for offshore renewable energy developments” on Integrated Offshore Emergency Response
-	UK Energy Institute’s G+ “good practice guideline ‘offshore wind farm transfer”
IMCA M232	IMCA Standardised Boat Landing Research Report and

4 GENERAL

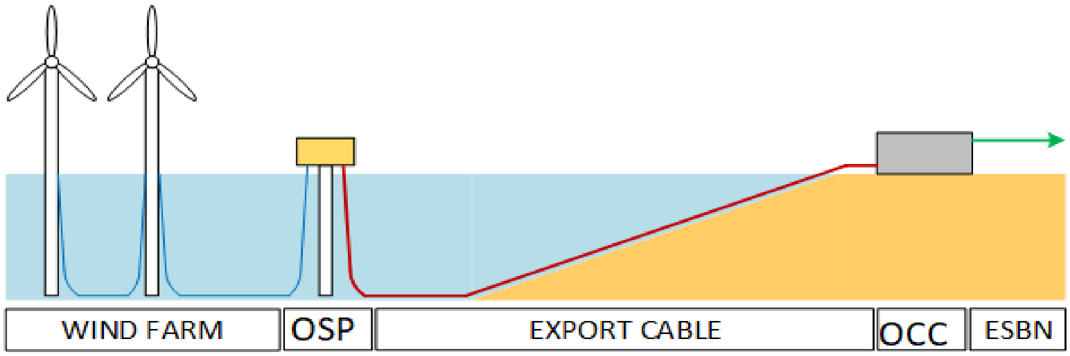

Figure 2 – Offshore Windfarm grid connection delineation

4.1 PURPOSE OF OSP

The OSP shall:

- Act as an interface between the array cables collecting the power produced by the wind turbines and the submarine export cable system;
- House all EirGrid and IPP electrical equipment and supporting systems and protect this equipment from the harsh offshore environment;
- Form a critical link to the safe operation of the windfarm in terms of SCADA, control, and safety systems. It will act as a central hub for the offshore portion of the WF SCADA system, and provide the main shoreside link for same;
- Provide a place of safety for the personnel during installation, commissioning, operation, service and maintenance and decommissioning phases;
- Provide safe access and egress during normal operation, maintenance and emergency situations;
- Protect the environment from any impact or spillage from the OSP housed equipment;
- Provide safe shelter for stranded mariners

4.2 INTERFACES/OWNERSHIP BOUNDARIES

In developing the OSP structural design, main and auxiliary power systems, accompanying support systems and safety and environmental protection systems, the Customer shall take cognizance of the multiple interfaces to be considered, for functional areas such as, but not limited to:

- Main circuit interfaces;
- High Voltage Safe Systems of Work (as defined by Customer's own relevant procedures and Safety Rules);
- Power supplies from the auxiliary (LV) electrical system and UPS;
- Control and Protection interfaces;
- Fibre optic cable interfaces;
- Mechanical interfaces;
- HVA/C system focusing on cooling / evacuation of heat from Customer rooms/equipment (if applicable);

- Drain system;
- Material handling system for onboard and offboard continuation purpose;
- Water system with black and/or grey water (when applicable);
- Fire protection system;
- Platform safety system;
- Communication system;
- Platform illumination system;
- Earthing and bonding;
- Layout and structure (logics);
- Any other Customer related systems and/or equipment interfaces

An interface matrix and agreement shall be developed between the Customer and EirGrid on a bilateral basis as part of the engagement on project level.

4.3 DEFINITION OF THE WORKS

For the purpose of this specification, the OSP part of the Contestable Works (hereafter the Works) shall be defined as the entire engineering and design, procurement, fabrication, transport, installation and commissioning, energisation and handover of a fully reliable and fit-for-function OSP including sub-systems and interfaces.

This section is not intended to give a comprehensive listing of the full scope of works associated with the delivery of the OSP. The Customer shall establish the Scope of Works and all requirements for its contractor(s). Furthermore, the project-specific elements of the full Contestable Works will be defined in the Connection Agreement.

The Customer shall:

- Deliver a fully reliable, safe and functional OSP as minimum specified in this document and associated EirGrid specifications;
- Comply with EirGrid’s specifications, procedures and policies as well as relevant standards, laws and legislation;
- Ensure compliance with the Irish Grid Code.
- Secure all necessary consents and third-party agreements to enable completion of the Works, and discharge any conditions therein;
- Conduct all surveys (pre and post construction);
- Prepare, and propose to EirGrid for review, and maintain a project execution plan and detailed programme and provide regular reporting against key milestones;
- Prepare, and propose to EirGrid for review, maintain and implement a Quality Management Plan, as well as to inform EirGrid of any arising quality issues;
- Ensure certifying authority verification and certification as per document OFS-GEN-004.
- Prepare, maintain and implement an Interface Management Plan, interface registers and drawings;
- Prepare, and propose to EirGrid for review, maintain and implement a Safety and Health Plan (as per Safety, Health & Welfare (Construction) Regulations 2013;
- Prepare, and propose to EirGrid for review, appropriate safe systems of work, including but not limited to: method statements, procedures, operation and maintenance manuals, lifting plans and other documents with the associated risk

assessments necessary to ensure all construction and commissioning works can be completed successfully and to the required HSE standards;

- Prepare and propose to EirGrid for review, maintain, and implement project specific reliability, availability, maintainability and safety by design (RAMS) strategy which links to health and safety, environment and service & maintenance strategies;
- Prepare, and propose to EirGrid for review, maintain and implement an Environmental Management Plan;
- Prepare, and propose to EirGrid for review, maintain and implement an Inspection and Test Plan and inform EirGrid in due time of key test activities to allow attendance of EirGrid representatives;
- Provide the required information for the Health & Safety File;
- Plan and execute all Pre-Commissioning and commissioning activities;
- Provide training for EirGrid's nominated personnel;
- Prepare and propose for EirGrid review an Operations and Maintenance (O&M) manual including method statements for repairing and replacing equipment for all platform/stations systems;
- Prepare and propose a spare parts strategy and spare parts holding for EirGrid review;
- Consider decommissioning in the design, prepare a decommissioning plan including method statements

4.4 HEALTH SAFETY AND ENVIRONMENT

The Customer shall observe and comply with all relevant and current statutory requirements, approved codes of practice and industry guidance as well as requirements from the respective Irish Authorities on health, safety and environmental (HS&E) and where applicable maritime security matters relevant to the Works.

The Customer shall be responsible for ensuring that all of the Customer's personnel and all of the Customer's supply chain personnel, (i.e. sub-contractors etc.) comply with all of the relevant HS&E legislation and that all personnel are appropriately trained, inducted and competent for the tasks they are required to undertake.

The Customer shall also ensure that it is possible and practical for the future operation, service and maintenance of the Project to be performed safely and in compliance with all the appropriate statutory acts and regulations.

4.5 REVIEWS

Project documentation prepared by the Customer (and its contractors) shall be submitted to EirGrid for review. An MDR shall be prepared by the Customer at an early stage to allow EirGrid to plan resources for reviews. Time shall be incorporated into the programme to allow for a reasonable review period, and for the Customer to revise and update the documentation based on comments received.

See "OFS-GEN-012 Review and Oversight Procedure" for further details.

4.6 QUALITY ASSURANCE AND QUALITY CONTROL

4.6.1 THIRD PARTY CERTIFICATION AND VERIFICATION

Customer is to ensure that all elements of the Works are either verified or certified as per OFS-GEN-004 Certification and Verification Requirements.

4.6.2 QUALITY ASSURANCE SYSTEM

Certification according to ISO 9001 or equivalent is required for the Customer's contractors/suppliers. Customers shall provide evidence of current registration to this standard and shall provide a Quality Manual and an outline of the manufacturing process controls in the English language. Detailed information on Quality Assurance and Controls and work instructions shall be made available.

4.6.3 QUALITY ASSURANCE PLAN

The Customer shall prepare project and site-specific Quality Assurance Plans for review by EirGrid.

4.6.4 MATERIAL WORKMANSHIP

All materials and workmanship shall be of a suitable type and quality as per good wind industry practice, as defined in ISO 29400.

4.6.5 DISCLOSURE OF DEFECTS FOUND

The Customer shall inform EirGrid in the event of quality issues, identified by the equipment manufacturer and which are likely to cause an impact on equipment after installation. In the case of major defects being detected the Customer shall provide a preliminary non-conformity report after receipt of the goods, and thereafter a final comprehensive non-conformity report.

The Customer shall notify EirGrid of any quality issues or defects which may subsequently come to light.

EirGrid reserves the right to audit equipment manufacturers to ensure compliance with this specification and its requirements.

4.7 DEROGATION PROCEDURE

The Works shall comply with all EirGrid's specifications unless any deviation which has been specifically requested by the Customer is accepted in writing by EirGrid. Where deviations from the functional specifications are proposed in the design, the Customer shall submit a formal Derogation Request providing a detailed explanation of why the non-compliance is expected and any additional information to support the request for EirGrid to consider and review on a case-by-case basis.

Further information is outlined in EirGrid Derogation Process OFS-GEN-024. Early engagement, during the pre-construction phase with EirGrid is required for any proposed deviations.

5 CONTRACTOR'S SERVICE EXPERIENCE

5.1 SERVICE EXPERIENCE

The customer shall demonstrate that the contractors they propose to select have the necessary capability, capacity, competence, experience, facilities and geographical coverage to deliver the Works in a competent and timely manner.

The Customer shall ensure that the chosen contractor has:

a) At least 5 years' experience in delivering the Works as defined in this specification.

b) Service experience:

   i. Supply and installation of the "Works" in at least three offshore wind projects in EU / EEA / UK economic sectors.

   ii. service experience for the product range of at least 5 years duration.

c) As an alternative to such experience within the EU / EEA / UK, similar experience with Swiss, Japanese, Australian, South Korean or US / Canadian utilities would be considered.

d) At least 5 years of production in the particular plant proposed is required, although if the particular plant proposed is a relocated existing plant using substantially the same workforce, the combined time of both plants would be considered.

e) At least 5 years of production in the particular fabrication yard proposed is required, although if the particular fabrication yard proposed is a relocated existing plant using substantially the same workforce, the combined time of both plants would be considered.

f) The products being offered to EirGrid must be manufactured in the same plant and yard which produced the products which are cited as meeting the service requirements outlined in the conditions (b) and (c) above.

If the Customer wishes to propose contractors with less experience or track record than the requirements listed above, the Customer shall inform EirGrid, and clarify how the lack of experience can be mitigated.

The fabrication yard where the platform will be manufactured shall have certification regime according to ISO 45001 ensuring minimum HS(E) requirements are met ensuring personnel working in such environment are working under assessed and mitigated occupational health and safety conditions.

In situations where contractors form JVs for delivery of the contestably built assets, the Customer shall document how the JV will fulfil the above requirements for all parts of the Works, and how this will be safeguarded contractually.

If the Customer wishes to include contractors/suppliers from other regions or countries listed above (such as the APAC region), these shall be proposed for EirGrid review and acceptance.

Relevant industry experience from O&G could also be accepted (e.g. power from shore or similar; Experience with HV is key).

6 SERVICE CONDITIONS

6.1 NETWORK PARAMETERS

The system design information is as per Table 6 below:

Table 6 Network Parameters

Description	220 kV	400 kV	LV aux
Nominal Voltage	220 kV	400 kV	400 / 230 V ± 10%
Highest Network Voltage	245 kV	420 kV	440 V / 253 V
No. of Phases	3	3	3, 4 wire
Frequency	50 Hz	50 Hz	50 Hz ± 2.5 %
Neutral Point	Directly Earthed at selected points	Directly Earthed at selected points	Directly Earthed
3 Phase Short Circuit Level (rms)	40 kA	50 kA	16 kA[1]
Duration of Short Circuit[2]	1 s	1 s	1 s
Peak Short circuit current (peak)	100 kA	125 kA	N/A

A typical system X/R ratio of 14 shall be considered except in the following circumstances:

[1] This is the standard value for design of LV equipment in Transmission substations,

[2] This value is the maximum, to be used for equipment withstand purposes. Alternative clearance times and network parameters shall be considered for various protection and earthing calculations in accordance with the relevant functional specifications.

- Designated substations, where a higher value has been outlined.
- CT suitability calculations where a minimum X/R value of 25, or as outlined in the project protection specification, shall apply.
- Busbar forces calculations, where a minimum X/R value of 25 shall apply.

The Customer shall consider the capacitive and inductive switching requirements in accordance with the project specific requirements and the relevant functional specification for the switching devices. All EHV circuit breakers shall be single pole devices and with the facility to act in conjunction with Point-of-Wave switching relay.

Table 7 indicates values for minimum insulation levels:

Table 7 Insulation Levels

Description	**220 kV**	**400 kV**
Rated voltage (U_r) kV (rms)	245	550
Rated power frequency withstand voltage		
(U_d) kV (rms) Phase–earth & phase-phase	460	620
(Ud) kV (rms) Across isolating distance	530	800
Rated lightning impulse withstand voltage		
(U_p) kV (peak) Phase–earth & phase-phase	1050	1550
(U_p) kV (peak) Across isolating distance	1200	1550 (+315)[3]
Rated switching impulse withstand voltage		
(U_s) kV (peak) Phase–earth	N/A	1175
(U_s) kV (peak) Phase–phase	N/A	1760
(U_s) kV (peak) Across isolating distance	N/A	900 (+450)[3]

For 220 kV no switching impulse level is assigned, and the clearances are dictated by the BIL.

LV equipment shall have rated power frequency withstand rating of 2 kV (rms) for 1 minute. This has an equivalent rating of 3 kV across the isolating distance.

[3] Note: The values in parentheses are the peak values of the a.c. voltage applied to the opposite terminal.

The Customer shall submit fully completed and signed Technical schedules for outlining the HV switchgear parameters to EirGrid for review.

6.2 Site Specific Environmental Conditions

6.2.1 General Requirements

Customer is responsible for establishing the site-specific environmental conditions. These will form part of the design basis.

The OSP shall be suitably engineered, designed, procured, constructed, and installed to remain operable throughout the intended operational life as specified in section 7.2 within all foreseeable prevailing conditions.

Equipment, systems, and materials shall be selected based on their suitability for offshore and marine application.

Indoor equipment vulnerable to the effects of frequent condensation and moisture shall be located in a climate controlled and regulated environment.

Outdoor equipment design shall also consider the effects of wind driven rain, solar radiation, humidity (up to 100%) and exposure to high winds and a salt laden environment.

Restrictions in terms of electromagnetic fields, noise level, temperature, humidity, and level of vibration shall be considered according to national workplace health and safety requirements.

7 Design

The Customer maintains overall responsibility for the design and any review, comments, approval or acceptance by EirGrid on reviewed material does not reduce or limit the Customer's design responsibility.

7.1 Design Basis

Customer is responsible for establishing the design basis for the OSP and overall power system design, see document OFS-GEN-005 Network Engineering Studies specification.

Prior to the start of the design work, the design basis will be subject to EirGrid review as well as third-party certification, as per “OFS-GEN-004 Certification and Verification Requirements”.

The Design basis shall address the following aspects including but not limited to:

- All relevant standards, codes, regulations and guidelines on which the design will be based
- Due consideration of EirGrid specifications, policies and other relevant requirements

- Design philosophies and design goals guiding the design, including due consideration of EirGrid's specifications
- Physical site data (such as water depths, geophysical/geotechnical, bathymetric, seabed conditions, meteorological and oceanographic conditions and environmental data) including interpretation of such data as well as data quality
- Any relevant consent requirements or third party imposed restrictions;
- Grid Connection Agreement
- Overall electrical system design and strategy for achieving grid code compliance
- Other electrical data and output from network engineering studies supplied in the Electrical Basis of Design, to be developed by the Customer as part of the Power System Philosophy document
- Overall Protection System, SCADA and Telecommunication systems design
- OSP Condition monitoring
- Wind Turbine Generator data (electrical)
- Transport & Installation concept / design
- Export and Array Cable parameters (such as physical dimensions, CSA, bending radius and weights/loading)
- Description of key interfaces
- RAM(S) methods, tools and techniques to be applied throughout the design process
- Any other assumptions

With reference to Guidance note 2 in section 4.2.3 in DNV-ST-0145 it is required, in the initial stages of the design process, to establish a design brief with a description of the main design methodologies. Design briefs shall be established for all major platform systems and equipment and shall be made available for EirGrid review.

Both the design basis and design brief are subject to review by EirGrid.

7.2 Design Life

All main electrical components on the OSPs shall have a design life of 40 years (unless otherwise stated within the individual technical specifications.

Any equipment or systems offered which have a shorter expected design life shall be clearly identified and shall be subject to review by EirGrid. Any need for replacement of components and systems shall be considered in the material handling study.

The design life of the rest of the OSP including topside structural elements and substructure/foundation shall be minimum 40 years.

7.3 Design Philosophy

7.3.1 Design Goals

EirGrid has defined the following minimum design goals seen from an asset owner's perspective.

- Minimise the risk to personnel and the environment during the platform construction, installation, commissioning and operation phases;
- Maximise asset availability, reliability, maintainability and survivability;

- Minimise unavailability of the transmission system function;
- Minimise the lifecycle costs (CAPEX + OPEX + DECOMEX);
- Maximise the protection of personnel and equipment from exposure to and degradation from the offshore elements, including environmental loads;
- Minimise the need for personnel transfers and offshore working by minimising the need for inspections and maintenance and through use of condition monitoring;
- Minimise collection of water on platform flooring;
- Minimise the need for cleaning of bird guano;
- ALARP demonstration in the design and execution looking at risk reduction measures towards:
  - Working at height;
  - Working over the edge and avoidance of MOB situations;
  - Confined space (including foundation);
  - Minimise the need for temporary scaffolding;
  - Substation material handling and use of mechanical lifting aids;
  - Diving;
  - Lifting;
  - Access and egress;
  - Escape, evacuation and rescue and recovery;
  - Slips, trips and falls;
  - Water pooling;
  - Biological hazards including guano;
  - Structural and mechanical;
  - Works in an electrical plant and near live appliances (including radiation);
  - Hazardous substances (including containment volumes);
  - Platform fire and explosion;
  - Hazards due to working/living environment conditions;
  - Any other hazards arising from the systems including malfunction and failures;
  - Ergonomic design including accessibility;
  - Emergency response and evacuation, and;
  - Mental load.

In addition to the above, the Customer is to take due consideration to lifecycle costs in the design of the OSP, balancing CAPEX, OPEX and DECOMEX. Reducing CAPEX shall not lead to increases in lifecycle costs or increase operational risks.

The Customer shall consider all operation, service and maintenance activities to help minimise overall asset life cycle costs as well as ensuring safe and efficient operation of the assets at all times.

The Customer shall complete the above list and define further design goals as necessary for EirGrid review.

Best practice shall be demonstrated by the Customer through early-stage design risk assessment and ensuring safety by design, focusing on all stages of the OSP life cycle.

7.3.2 REDUNDANCY

EirGrid does not mandate redundancy in the main export power system circuits, although it would be technically acceptable if this were proposed by the developer. . Redundancy is however required in the auxiliary power system, telecommunication, control and protection systems and any safety critical systems.

7.3.3 Reliability of Service Function

The Customer shall ensure that risks of the scenarios below are minimised:

- Loss of main power
- Loss of auxiliary power
- Loss of control/communication

The Customer shall demonstrate the level of risk through RAM analysis or similar for the above events.

The Customer shall execute a (preliminary) RAM study and required underlying FMECA studies to prove the design lifetime and identify necessary time and or condition-based maintenance to substantiate the design lifetime requirement.

7.3.4 Operations and Maintenance Philosophy

As part of the OSP design process, the Customer is to propose an operations and maintenance philosophy on which the design shall be based. This O&M philosophy will be subject to EirGrid's review and acceptance. The O&M philosophy shall take due consideration of the following:

- The design goals and design philosophies specified in this specification, and associated EirGrid specifications;
- The site-specific parameters and conditions, with special emphasis on limitations on offshore working due to seasonal weather variations;

The overall maintenance philosophy is to minimise costs, consistent with meeting OSP availability demands and achieving legal / regulatory compliance. Central to this philosophy is the objective to limit any need for physical intervention (and thus for personnel presence on the OSP) to the greatest extent possible.

Given the goal of minimum intervention, primary requirements will be to:

- Utilise proven condition monitoring technology to facilitate the remote surveillance of equipment health and provide forewarning of any degradation;
- Ensure OSP design, layout, storage and working areas facilitate ease of maintenance on a condition-driven, planned or opportunistic basis;
- Pre-plan for foreseeable equipment repair scenarios, replacement and re-instatement scenarios;
- Ensure easy access to all maintainable equipment parts.

An Operational Criticality assessment shall be conducted during design that considers the risks to safety, the environment and OSP availability performance presented by the functional failure of discrete systems, sub-systems and equipment. Where applicable, consideration of availability performance impact will reference the results of a RAM analysis.

The Customer is to prepare a maintenance program and suggested critical spares holding for EirGrid review. Equipment failure rates and anticipated repair times, as well as other relevant information shall be made available by the Customer to allow EirGrid to develop a business continuity plan.

7.3.5 Manning

In DNVGL ST-0145 different types of manning are defined for the purpose of focussing design requirements based on the type of manning. The manning types are:

- *Type A: unmanned substation containing main power system as defined in [5.4.1.1]. Persons are only expected to be present for inspection and maintenance activities without overnight stays between working shifts. If habitability services are provided, they are limited and intended solely for the use during the working shift not facilitating for overnight stay.*
- *Type B: temporarily (i.e. overnight stays between working shifts are assumed to take place, even if irregularly) or permanently manned substation containing main power system as defined in [5.4.1.1] and accommodation spaces. On departure of personnel from the substation all systems shall be returned to a safe and unmanned state, without adding additional hazards such as legionella developing in water systems.*
- *Type C: a separate accommodation platform or an accommodation platform connected to another substation by a bridge.*

The manning strategy will be based on the visiting strategy for the required operational and maintenance tasks on the OSP.

The target manning strategy for EirGrid is to achieve unmanned operation, type A as per the definition above. Nevertheless, the Customer is to document that this can be achieved.

The design shall minimise the requirement for offshore mobilisation as much as practicable under both planned and un-planned maintenance conditions. The OSP shall be designed for remote operation from the onshore control station. Only for some (limited number of) HV switching operations personnel will need to go to the OSP to ensure proper and safe operations.

These operation, inspection and maintenance requirements are dictated by:

- Internal operating procedures for HV switching requiring local presence;
- Regulatory compliance for e.g. lifesaving equipment, lifting equipment, detection systems, firefighting equipment and systems, navigational aids;
- Assurance of continuation of operation (reliability and availability) for HV equipment and critical auxiliary equipment.by performing preventive and corrective maintenance.

Given the above platform visiting requirements a manning philosophy shall be developed by the Customer for EirGrid review. The Customer shall consider the following:

- Maximum number of persons on board (POB) documented on the basis of design documentation;
- Methods of access and egress;

- Means of transportation for personnel, goods, tools and spares; and
- Limits of weather conditions allowing for transport to and from the substation shall be considered. The considered conditions shall include wave height, tides, wind speed, visibility, temperatures, and daylight hours.

The manning strategy is divided into two types of visits:

- Planned (routine) visits; and
- Unplanned (reactive) visits.

Planned visits are driven by:

- Preventive maintenance activities based on defined individual maintenance and inspection requirements for all maintenance objects on the OSP; and
- Verification and/or independent certification activities initiated by internal and external compliance processes or regulation.

Unplanned visits are driven by:

- Break down or corrective maintenance

Major maintenance campaigns are generally performed with the purpose of effective use and minimization of offshore activities. The Customer is to propose a suitable strategy for such campaigns.

As per EirGrid's target manning strategy, it is expected that persons are only to be present for inspection and maintenance activities without overnight stays between working shifts.

In the event that an overnight stay is required, because of unforeseen inclement weather, critical or increased duration activities, temporary provisions shall be made for the safe and comfortable accommodation of the working parties within the design of the Temporary Refuge and/or through providing temporary equipment and goods, together with the work party.

7.3.5.1 Considerations around Type A vs. Type B

The suitable manning principles will largely depend on the number of visits that are required to ensure the required availability of main power system.

If more visits are needed to maintain the required availability, the costs of transfer may weigh up against the costs of maintaining living quarters. Also, with more visits, personnel may be exposed to the increased transfer risk weighing up to the risk of staying on the platform overnight.

The Customer shall describe the impact on the design if the platform is classified as type B (planned overnight stays, not more than several days), including but not limited to the following areas:

- Provisions for accommodation ;

- Provisions to ensure the habitability of the accommodation spaces in case of emergencies;
- Requirements for lifeboats for maximum POB (assuming that CTV will not remain overnight);
- Provisions for additional redundancy of systems that are critical for the safety of persons in the accommodation.

7.3.6 MAXIMUM PERSONS ON BOARD (POB)

For the specification of lifesaving appliances and accommodation requirements, the maximum allowable number of persons on board of the OSP needs to be defined.

The Customer shall define minimum and maximum number of persons expected to be on the substation at any time for all relevant types of work and foreseeable emergency situations.

Major maintenance campaigns may require more persons working on the platform than the POB. In these situations, a specific assessment must be performed on the available lifesaving appliances and the additional (temporary) lifesaving appliances to be installed on the platform for the period of the maintenance campaigns. The Customer shall set out their assumptions for this at design stage.

National legislation shall be followed. Under no circumstances shall the POB be less than 3[4].

7.3.7 ACCESS/EGRESS

7.3.7.1 NORMAL ACCESS

The customer shall propose an access/egress and transfer concept for EirGrid review based on site-specific conditions, O&M needs and project parameters.

The method transfer is for a large part determined by the purpose of the visit, the transport distance and the availability of the means of transportation. The purpose of the visit is to be further described by the Customer in the Manning philosophy.

EirGrid has made the following assumptions:

- The primary method for transfer of personnel is by a crew transfer vessel (CTV) via the boat landings provided on the platform.
- Secondary, provisions shall be made for a Walk to Work (W2W) system, using a service operation vessel (SOV), and would be considered as an alternative or

[4] To allow for competence in the execution of essential operation and maintenance activities, while being able to operate the asset in local mode and effect the recovery of an injured person (IP) in the event of an incident or accident.

back-up for the CTV or used in combination with a flotel during service & maintenance or overhaul campaigns.

- Tertiary means, via Helicopter transfer (winching) is optional and subject of an assessment weighing operational, technical and economic factors. The actual requirement for helicopter transport in the operation and maintenance of the OSP should be based on an assessment of the operational advantages and disadvantages weighted against the additional costs involved with the installation. It may, however, be considered the only and preferred means for urgent reactive or emergency (MEDEVAC) visits.

For requirements regarding these systems, see Section 8.4.

7.3.7.2 Access/Egress and Transfer by Air

Transport by air shall be in accordance with local aviation and maritime regulations. The Irish Aviation Authority does not presently have legislation on Helicopter Landing/Winching Areas for offshore helicopter landing areas. However, policy documents (CAA CAP 437: Standards for Offshore Helicopter Landing Areas) produced by the Civil Aviation Authority (UK) may be used as an acceptable standard. The winching area should be arranged with consideration of the rotor diameter of the SAR helicopters likely to be tasked to the installation in an emergency.

Note: At the time of issuing of this specification, DECC/HSA are still working on an offshore safety regime. The Customer shall pay attention to any changes to legislation or regulations in this area.

7.3.8 Emergency Egress

Emergency Egress, i.e. Escape and evacuation, refers to the planned method of leaving an offshore substation in case of an evacuation of an IP, or in an emergency without directly entering the sea. Successful evacuation results in those on board of the OSP being able to muster at a safe area on the substation and then being transferred from the substation to a Place of Safety.

The OSP Emergency Response Plan will describe all emergency situations and the response actions.

The means for emergency escape and recovery are:

- Primary: Via CTV (or W2W solution, as the case may be) if time, exposure to hazards and the mobility of personnel allows;
- Secondary: Via helicopter, if it is safe for the helicopter to approach, hover and recover personnel; and
- Tertiary: Via life-rafts/escape to sea devices.

7.3.9 Escape, Evacuation and Rescue Analysis (EERA)

Escape, evacuation and rescue analysis (EERA) is widely used in the offshore industry and suggested in ISO 17776, ISO 15544 and DNVGL-ST-0145 considering safety studies.

Along the design and at design freeze of any stage, and updated, re-assessed at any design stage or alteration or change when any changes are done to the platform design, an EERA is to be undertaken and aligned with EirGrid for review and acceptance. EERA shall be conducted by an "experienced" and "competent" safety engineering professional with expertise in this area.

7.3.10 PLATFORM ORIENTATION

The orientation of the substation, with respect to prevailing wind, wave and current direction, shall be considered as per DNV-ST-0145, taking due account of the array and export cable routing, access/egress strategy, mechanical handling and potential jack-up areas.

The layout shall position the platform's foundation connected boat landings away from the prevailing wave direction such that personnel can safely transfer to and from vessels during sea state conditions with waves of up to (Hs) – basically as per vessel's seagoing capabilities and still allowing safe transfers according to industry's general practice.

Platform orientation shall consider sufficient space and safe access to facilitate replacement of large, heavy equipment that cannot be handled by the offshore platform's own material handling system.

The layout and orientation shall position the OSP as central as possible and within adequate distance of the offshore wind farms, whilst also:

- Minimization of the cable length (export and infield cables)
- Minimization of the risk on collision with vessels
- Minimization of spatial usage, i.e., making use of overlapping safety zones etc., and
- Guaranteeing accessibility by vessel and helicopter

The field layout and orientation shall ensure the outer edge of the OSP is at a distance of at least 500 m from any other infrastructure.

7.3.11 TYPE OF STRUCTURE

The type of platform structure may be an open deck, portal/pancake structure, truss structure or hybrid structure.

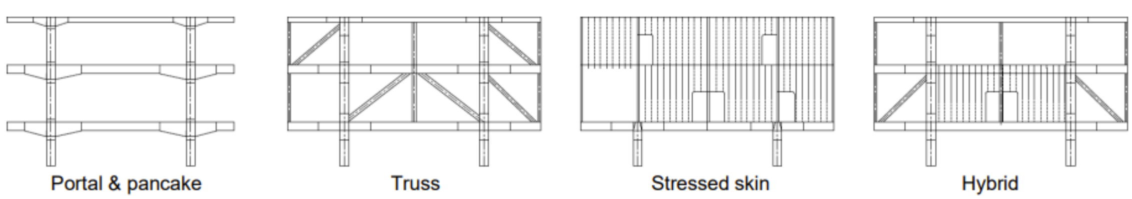

Figure 3: Structure types

Each type has its own design aspects with respect to strengths and weaknesses[5], but also have an influence on layout, late design change flexibility and fabrication. Additionally, fabricators are often more suited or specialised in fabricating one type over the other. The choice for either type of structure, may therefore also depend on the (strong) preference of the awarded fabricator. In order not to exclude fabricators / competitors at forehand, the topsides concept should ideally be suitable to be adopted for either type of structure.

7.3.12 CABLE PULL-IN

The Customer shall plan and make arrangements for the need to replace export and array cables. The Customer shall propose method statements for these operations to EirGrid for review.

Cable routing from the cable deck to the switchgear terminations should be designed to enable the most practical cable pull in, handling and termination solutions, including due regard of foreseeable replacement and repair actions.

The structure shall withstand all forces exerted upon it during cable pull-in operations in compliance with DNVGL-ST-0359 subsea power cables for wind power plants as a minimum.

7.3.13 MATERIAL HANDLING STRATEGY

Material handling systems shall support the platforms maintenance concept as well as the construction and commissioning phase, to allow for safe and efficient usage, with a minimum number of lifting and handling appliances.

The customer shall propose a material handling strategy to support operation and maintenance activities, for review and acceptance by EirGrid. Method statements for replacement operations shall be defined and built into the operations and maintenance plan and platform material handling strategy.

Material handling processes shall seek to minimise interruption of the platform’s energy transmission. In designing the material handling processes, in case of conflict, availability shall take priority over efficiency.

Local handling facilities shall cover all possible handling requirement for maintenance on the related equipment and components, for the following operations:

- Handling during normal operation (consumable, lubricant etc.)
- Routine maintenance during normal operations
- Periodic visits and inspections of equipment and parts
- Planned preventive maintenance operations

[5] Note: Examples of pros and cons across different types of structures can be strength, stiffness and robustness, impact protection, damage resilience, environmental protection, equipment access, removal and reinstatement, etc.

- Servicing maintenance and major overhaul on failure of equipment or of their components

Method statements for replacement operations shall be defined and built into the operations and maintenance plan and material handling strategy.

See section 11.2 for further details of material handling system requirements.

7.3.14 Fire and Explosion Protection

The minimum requirements on fire safety shall be ensured as per DNV-ST-0145 and therein referenced documents in conjunction with this specification and applicable national and international regulations and technical standards.

The Fire and Explosion Protection Strategy for the OSP shall be based on the credible fire and explosion scenarios identified for the equipment and activities on the OSP in combination with the loss prevention philosophy for the OSP.

The objects of protection are:

- The people on board;
- The environment;
- Control stations;
- Places of designated temporary refuge, as may be occupied from time to time;
- Muster locations, from where evacuation is affected; and
- The assets of the platform and its equipment.

The safety of people on board must be ensured at all times in any fire or explosion scenario.

The fire and explosion protection strategy should follow the inherent safe design principles:

1. Elimination of the fire or explosion hazard. An example is the use of dry transformers eliminating the hazard of pool fires of insulation oil
2. Fire or explosion hazard reduced in risk by substitution. An example is the use of ester oils in transformers with much lower flash points and ignition probability.
3. Prevention of fire or explosion event. An example is the application of fire resistant or flame retardant cabling.
4. Limit damage to equipment from the fire or explosion. An example is the use of fire detection and automatic firefighting systems
5. Prevention of escalation of the fire or explosion to other (safe) areas. An example is the containment of equipment in fire/blast rated divisions (walls, decks).

Principles 1, 2 and 3 should always be implemented when feasible and cost- effective. Principles 3 and 4 should be implemented based on the risk to people and asset.

7.3.15 Corrosion Protection Strategy

The Customer shall prepare and implement a corrosion protection strategy which will demonstrate that the design life can be achieved whilst minimising asset life cycle costs. This shall be provided to EirGrid for review and comment. The corrosion protection strategy shall consider the following:

- Material selection and material corrosion resistance;
- Corrosion allowances;
- Corrosion protection system;
- Consideration of barriers such as insulation, fireproofing and shielding;
- Fatigue analysis (e.g. S-N curve selection and thickness loss allowance);
- Maintenance actions (e.g. re-coating and other actions)

The corrosion protection strategy shall be in line with the relevant standards and industry best practice. The maintenance requirements of the proposed corrosion protection system shall be included in the maintenance program and manuals.

For further detail, see section 8.5.

7.3.16 Back-Up Power Supply Philosophy

See OFS-OSP-136 Auxiliary Power System Specification.

7.3.17 Black Substation Philosophy

A 'Black substation' condition is understood to mean that the auxiliary power supply system is out of operation and that services required for the restoration of the auxiliary power supply system are not available. Batteries for starting of all generator sets are considered discharged.

Means for the restoration of the auxiliary power supply upon 'black substation' condition shall be included in the design, and a procedure proposed by Customer for EirGrid review. A complete black start procedure shall be created during the basic and detailed engineering phase.

A black start philosophy could for instance include provision for a back-up diesel generator, supply from a service vessel, or other form of power supply. Strategically placed power supply sockets will allow for direct supply from the temporary back up power supply to one of the main LV AC distribution boards. Earthing and Lightning Protection

The Earthing and Lightning protection design shall follow the requirements of DNV-ST-0145.

7.3.18 Bunkering Philosophy

Planning and execution of bulk transfer of transformer oil, oily water, diesel, potable water, etc. shall be performed with due consideration to environmental risk. Procedure shall be based on risk assessment. Customer shall propose solution for refuelling and associated risk assessment for EirGrid review.General Design Requirements

This section is supplementary to the requirements presented in the design philosophies above.

7.3.19 DESIGN PROCESS

The design of the platform and substructure may be split into the following phases, as envisaged in EirGrid's Design Review and Oversight process (OFS-GEN-012):

- Concept design (or Planning Design, as the case may be) ;
- Front End Engineering Design;
- Detailed design.

As each Customer's approach to ORESS1, their quality management systems, design process and risk appetite may vary, so will the level of detail and timing of the above design steps. As such, EirGrid has allowed a flexible design process whereby the Customer shall define and inform EirGrid of the envisaged design process based on project specific parameters.

The Customer shall issue a master document register (MDR) for all stages of the design. Based on this register EirGrid will define which documents are to be submitted for review or information respectively.

All drawings are to be submitted as complete documents with all sheets related to the same system or structure in one multi-page document. The submission of separate pages or sheets as separate documents shall not be accepted. See Section 0 for further details around requirements for document submissions.

7.3.20 DESIGN RISK ASSESSMENT

Safeguarding the integrity of the installation and the protection of persons on board shall be assured by the customer by providing the required safety systems and following a risk-based approach to health and safety. The final safety philosophy shall be submitted to EirGrid for review.

A design risk assessment (DRA) and risk management process (ISO or equivalent) is required to identify design risks due to specific potential hazards.

The risk assessment must ensure that the design is safe and without risk to health when properly used by a person at a place of work, considering the initial installation, time-based inspection, time-based maintenance requirements, operation activities and decommissioning equipment.

The required approach for risk analysis shall follow DNV-ST-0145 and shall include but is not limited to the following hazards:

- Electrical Environment:
  - Electrocution
  - Arcing, sparking and burning
  - High voltage stress/exposure of primary plant and equipment
  - Electromagnetic fields
  - Thermal stress/exposure of primary plant and equipment

    - Safety earthing, step and touch voltages under all operational conditions
    - Secondary auxiliary systems – optimal cable configuration, resonance and harmonics, effective earthing
- Physical Environment
    - Structural integrity or foundation failure
    - Fire hazard and explosion due to equipment failure;
        - exposure to internal arcs in SF6 or alternative insulation media
        - exposure to internal arcs in insulation (transformer) oil
    - Physical danger
    - Release of toxic or other hazardous substance (e.g. SF6 by products)
    - Radiation
    - Exposure to adverse weather and marine conditions
    - Oil handling and spillage
    - Corrosion
    - Collision – living (marine wildlife avoidance) & inert
    - Noise
- Operability Aspects;
    - Unplanned maintenance – “weather window”
    - Communication failure
    - Chemicals (e.g. oil, diesel) management – technical and maintenance requirements
    - Health and safety – transfer and access, escape and rescue;
    - Fire and explosion hazards
    - Replacement of equipment– centre of gravity and accessibility considerations

The DRA methodology shall be clearly defined and demonstrated by the Customer.

7.3.21 ROOMBOOK

For design reviews and general platform facility and area definitions, a so called “roombook” shall be in place ensuring all platform deck levels, locations and facilities are consistent with the naming convention but also that the following is kept in a rather single source:

- Deck level numbering and definition convention;
- Elevation of top structure;
- Room / area numbering regime;
- Facility definition as per DNVGL 145 (Chapter 6.4.2) and area segregation definition (Chapter 3.4);
- Equipment and appliances specifications;
- Drain fluids throughout;
- HVA/C coverage such as heat dissipation, manned and unmanned mode;
- Potential fire and gas loads for FERA calculations;
- HSE aspects e.g. human comfort data (lux level, temperatures, vibration et.);
- Facility communication systems, and;
- Lighting and small power;
- To list all rooms and their dimensions as well as door/gate or hatch openings to support the logics and requirements for material handling system.

The logics and sequence of the room book conventions, and name and numerical conventions, shall be referenced and used for all study and workshop types and review sessions.

7.4 Structural Design

The structural design process is to follow the principles in DNV-ST-0145.

7.4.1 Vibrations – plant and equipment

Equipment (primary and secondary systems) fatigue due to excitation from wind and waves can affect the long-term operating performance of electrical equipment.

In addition, vibration due to magnetostriction or "electric hum" from high power electrical devices (main transformers) can be transmitted to the platform causing maloperation of adjacent equipment. The customer shall demonstrate that risks associated with vibration due to magnetostriction or "electric hum" have been suitably mitigated.

The customer shall clearly demonstrate that the equipment and measures provided, such as resilient mounts, are designed to meet the motion effects resulting from excitation from wind and waves.

7.4.2 Vessel Collision

The OSP structure shall be designed to withstand a foreseeable vessel impact from an operating vessel (such as a CTV, supply or W2W vessel) visiting the OSP. This will be part of the structural basis of design.

The OSP structure (topside and substructure/foundation) shall withstand all loads encountered during ship impact conditions as defined by DNVGL-OS-C101 design of offshore steel structures, general - LRFD method for which studies are to be achieved and reviewed by EirGrid;

During ship impact, part of the energy released will be absorbed by local deformation. This energy shall be calculated according to e.g., Ellinas & Walker (ship impact analysis).

Where not already covered in the Marine Area Planning (MAP) consent, the Customer shall assess and consider in the design and siting of the installation. The risk of collision from sea vessels, to be determined from traffic patterns local to the substation platform, adjacent offshore installations and commercial shipping lanes (in consultation with local maritime and coast guards' agencies). Consequential environmental hazards may differ between jurisdictions.

In addition to the typical project submission, the location and design of the offshore substation shall be transferred in a suitable format for inclusion in the appropriate marine navigational charts.

Recommended Reference: IMO Regulation "Convention on the International Regulations for Preventing Collisions at Sea", 1972 (COLREG).

7.5 MATERIAL SELECTION

Material selection shall be made in accordance with EN 10255.

To meet DNV Grade FH (required for Special Structure for very thick wall) EN 10225 offshore steel will also require additional Charpy testing at -60°C or alternative tests.

7.5.1 MATERIAL CERTIFICATES

Structural steel shall be supplied with certificates in accordance with EN 10204, as per Table 7-1 Material certificates

Table 7-1 Material certificates

Material category	Material grade	Inspection certificate/report In acc. with EN 10204
Special structural steel [1]	All	Type 3.2
Primary structural steel [1]	EN 10225 and predominantly stressed when not at rest	Type 3.2
	EN 10225 and predominantly stressed when at rest and other	Type 3.1
Secondary structural steel	Grade > S275	Type 3.1
	Grade ≤ S275 and impact test ≥ 0°C	Type 2.2

Notes:

1. For all steel which is predominantly stressed when not at rest, certificate should include the following additional information:
   - 15 element analysis (chemical composition) – concentration of C, Mn, Si, S, P, Al, N, Cu, Cr, Nb, V, Ti, Mo, Ni, B
   - delivery condition AR not permitted
   - Marking of the authorised approval inspector
2. Hard stamping is not permitted for components subjected to dynamic load.

7.5.2 THROUGH THICKNESS PROPERTIES

Components that exhibit triaxial stresses and/or are loaded in the thickness direction, shall have improved through thickness properties.

Steels with requirements to the through-thickness properties shall not exceed the limit value of 0.005 % for sulphur, as determined by ladle analysis.

Through thickness testing shall be carried out in the final heat treatment condition. The test shall be in accordance with EN 10164, and the test results as follows:

- The through-thickness tensile strength shall be not less than 80 % of the minimum specified tensile strength.

- Minimum value for reduction of area shall be of Quality Class Z35.

Testing is not required for a product thickness below 25 mm.

8 OSP ARCHITECTURE

8.1 SYSTEM OF UNITS

8.1.1 GLOBAL PLATFORM COORDINATES

The platform location shall be specified in the UTM 30N system (Universal Transverse Mercator coordinate system). The reference point shall be the geometrical platform centre.

8.1.2 REFERENCE COORDINATE SYSTEM

Within all reports and drawings, the same global reference coordinate system shall be used, as far as applicable. The reference coordinate system is defined as follows:

- x-axis: horizontal, positive towards platform east
- y-axis: horizontal, positive towards platform north
- z-axis: vertical, positive upwards

The origin of the coordinate system shall be at the horizontal centre lines of the substructure at LAT. All elevations shall be referenced to LAT.

8.2 LAYOUT

The Customer shall ensure that the physical layout within the OSP complies with appropriate legislation, standards, safety clearances and safe working clearances.

Overall layout and orientation of the OSP shall take due consideration of:

- Configuration of inter array and export cables;
- Connectivity among equipment; - material handling;
- Accessibility to equipment, positioning of crane and lay down areas, transport to and from by sea (CTV / supply vessels) i.e. orientation of substructure and positioning of boat landings and platform crane (if applicable) with respect to the current directions;
- lifting, laydown and backload of containers or lifted loads;
- personnel and goods access;
- Helicopter flying pattern (approach and departure);
- Helideck position (if applicable) or winching spot position and layout orientation in particular with respect to prevailing wind directions, obstacle and turbulence free zones;
- prevailing meteorological conditions, and the orientation of the substructure with respect to predominant environmental load direction.

The layout shall be designed with due consideration of:

- Safe access and egress for personnel, tools and equipment;
- Dropped objects;

- Equipment spacing requirements;
- Maintainability;
- Access to Heli-hoist area;
- Mechanical and manual handling;
- Recovery and evacuation of injured persons;
- Proximity of personnel to HV equipment and cables;
- Environmental and weather protection, for personnel and plant;
- Fire and blast protection;
- Lighting;
- Cable routing;
- Leakages, spills, and containment measures and their design, capacity and location;Suitable space for a commissioning generator; and
- Laydown and utility connections for temporary containerised generators (during operations), temporary fuel containers, workshops, a rigging loft, etc.

8.3 MAIN ROOMS AND EQUIPMENT

8.3.1 POWER TRANSFORMERS AND REACTORS

Power transformers and reactors may be housed inside, outside or a combination (e.g. tank indoor and radiators mounted outside).

Further positioning will be influenced by the following parameters:

- Protection from direct exposure to rain, salt spray, guano, e.g. preventing accelerated corrosion of steel surface operating at elevated temperatures;
- The type of cooling system, e.g. tank mounted radiators, separately mounted radiators and as well as air- or water cooled radiators;
- The type of room conditioning (in case of indoor tank) controlled (HVAC) or natural ventilated;
- Leakage and spill containment arrangements following accidental emission of cooling medium;
- The component's weight; transformers are generally heaviest item on the platform and positioning is therefore a big influencer of the overall CoG of the platform.
- Accessibility in case of need for major maintenance works or replacement; typically access is provided through the roof by means of a hatch.

The positioning of the main transformer(s) is to take due account of cooling and ventilation needs as well as to allow for replacement and repair actions.

If placed indoors, air ventilation may be made possible through louvres installed in the walls, floor and or ceiling. The inlet and outlet louvres shall be positioned such as to create a cross flow through the room and around the equipment to achieve the best possible cooling. The roof will shield the transformers and shunt reactors from environmental elements such as rain, snow and ice as well as protecting the transformer against bird droppings.

Furthermore, the louvres should avoid rain ingress as much as possible, shall be sufficiently dimensioned to avoid roosting of birds and yet shall have sufficient cross flow area not to impede the natural flow of air for cooling.

Coolers shall be situated outdoors. The Customer shall propose for EirGrid review suitable arrangements to protect the coolers from bird droppings.

8.3.2 GAS INSULATED SWITCHGEARS

Gas insulated switchgear shall be housed inside within temperature and air-conditioned rooms. The location of the rooms will be influenced by the following parameters:

- Proximity to and connection with the inter array/export cables;
- Connection to and from the transformer and/or reactors

Switchgear shall be positioned to allow for direct pull-in of the export cables without the need for jointing.

Connections between switchgear and main power transformers shall be by way of cables or bus ducts. To facilitate possible replacement of switchgear components during the lifetime, the room shall be outfitted with safe and operable means of lifting, such as an overhead crane, trolley beam etc. Material handling strategy shall include proposal for foreseeable replacement and repair of entire switchgear.

8.3.3 AUXILIARY TRANSFORMERS

Auxiliary transformers are normally placed indoors in air-conditioned rooms, but naturally ventilated rooms or placement outdoors is also allowed.

Material handling strategy shall allow for replacement of the entire unit.

8.3.4 CONTROL AND LV ROOMS

Control rooms should be placed to minimise the overall length of cables, and be suitably protected from the possible impacts from fire and explosion hazards, with rated boundaries, including doors and windows.

Preferably the rooms should be location on the perimeter of the structure to allow placement of windows towards outside.

Rooms may be provided with a raised computer floor system or cable basement in the case of bottom entry in cabinets.

The room cabinet layout should be such that replacement of each cabinet is possible. Doors and headroom height along the transport route should be adequate to allow clear passage. To facilitate the transport of cabinets consideration should be given to raising the corridor or walkway to the same level as the system floor.

8.3.5 WORKSHOP AND STORAGE ROOMS

The maintenance strategy will determine the extent of and need for a workshop and storage space on the platform. Basic mechanical/electrical workspaces should be provided for in the design, incorporating work benches, shelving, a mechanical vice, utility power, ventilation and extraction arrangements, lighting, communication means and alarms.

It is envisaged that most spare parts will be stored onshore. Examples of storage needs on the OSP may range from fuses and bulbs to protection relays. The Customer shall propose a suitable strategy for storage of various components on the OSP.

A workshop may house tools and maintenance / transport equipment such as ladders, trolleys, skid rollers etc. The Customer shall ensure that transport of tools, equipment and materials to and from the workshop and storage room location(s) is covered in the material handling study.

8.3.6 Heating, Ventilation and Air Conditioning Plant Room

Heating and air conditioning systems provided shall be air based. HVAC could be realised through centralised or decentralised concepts. Customer shall propose HVAC design for EirGrid review.

8.3.7 Emergency Shelter/Temporary Refuge

A primary muster area (sometimes called the temporary safe refuge or shelter area) shall be provided to protect personnel from the effects of an emergency which is beyond their immediate control.

Access via boat landing shall be possible for potentially stranded mariners. Full access to the substation by unauthorized persons shall however be prohibited.

Minimum personnel and welfare requirements on the OSP shall be (type A):

- Rest area / Pantry
- Toilet
- Change room

Minimum personnel and welfare requirements on the OSP shall be (if type B):

- Sleeping cabins
- Sanitary rooms (lavatories, washing facilities and showers, male/female)
- Change room (male/female)
- Mess with kitchen
- Rest / Recreation area
- Potable water system

8.3.8 Temporary accommodation for commission and maintenance campaigns

The customer shall provide a detailed plan for temporary accommodation for commissioning and/or maintenance campaigns. EirGrid shall be given the opportunity to review the plan.

8.3.9 Doors and Windows

Door dimensioning shall take into account transport of equipment and tools as per the material handling strategy, in addition to the minimum requirements as per safety regulations.

Access to and for larger pieces equipment for maintenance may necessitate oversized double doors, sliding doors or removable wall panels. The type of door will also be based on the required opening direction, gas or weather tightness and fire rating.

Sliding doors are normally not permitted on escape routes, unless extra provisions are foreseen for emergency access/escape. But these doors can be provided with a smaller access/escape door if required.

For the control rooms and emergency shelter windows are preferable, but optional, as, if included, this will constrain the layout design for the OSP (as a minimum one side of the room would have to be adjacent to the outside wall). As such, EirGrid does not mandate windows for these rooms.

8.4 Access

8.4.1 Boat Landings

The following minimum requirements apply for boat landing design and operation:

- The access and egress system shall allow access to and egress from the platform via two (2) separate boat landings;
- Boat landings and landing platforms shall be positioned to maximise accessibility to the platform;
- The Customer may refer to the guideline issued by the Carbon Trust/Offshore Wind Accelerator[6];
- The Boat landing tubes shall allow for a vessel landing on a single tube with an approach angle of up to 45 degrees, without causing damage to the boat landing structure;
- Swing gates at intermediate platform shall be of self-closing type;
- Intermediate platforms as part of potential boat landing arrangement shall be concluded not to provide collision concerns during personnel transfer and vessel heave;
- Boat landing design shall consider latest IMCA Standardised Boat Landing Research Report (IMCA M232) and G+ good practice guideline ‘offshore wind farm transfer’;
- Repair and replacement of boat landings shall be considered by Customer in the design of the platform. Method statements shall be proposed;
- The design of the ladder system of the boat landing structure shall be in accordance with the ISO-14122;
- The top of the boat landing shall be fitted with a gate in accordance with ISO-14122. Gates shall be self-closing type. The top of the boat landing will be fenced

[6] https://www.carbontrust.com/our-work-and-impact/guides-reports-and-tools/design-for-recommended-boat-landing-geometry

from the OSP topsides areas to prevent unauthorised access and will be equipped with an emergency telephone to allow communication with stranded mariners;
- The top and bottom of the boat landing shall be designed to prevent CTVs from getting stuck on or under the boat landings in the event of a very high or very low tide, respectively.

8.4.2 GANGWAY LAYDOWN AREAS

The OSP shall be equipped with at least two (opposite) landing laydown areas suitable for Walk-to-Work (W2W) vessels using a motion compensated gangway system, to allow transfer of personnel to/from a vessel to the platform. The orientation and location of the W2W landing areas are such that in all possible wind, wave and current directions the W2W system can be utilised to transfer personnel.

The design of the W2W landings shall cater for all common and available motion compensated gangway systems applied in the industry (e.g. Ampelmann, Bargemaster, Uptime) and for the expected landing loads during W2W operations. The landing point shall have a gate to ensure safe entrance from the gangway to the platform. The gate shall be in accordance with ISO-14122. The gates shall be of self-closing type and fail safe. Sufficient clearance shall be considered in the design to avoid squeeze of person at MCG's tip-end and platform structure or platform equipment damage.

The design of the W2W landing should follow the guidance of the IMCA publication Guidance on the transfer of personnel to and from offshore vessels and structures.

8.4.3 FIXED GANGWAY CONNECTION

Landing points for connecting a gangway from a jack-up barge to the platform shall be provided, and take account of the export and array cable approaches/entries, j-tubes and cable protection systems. Cable free zones shall be proposed by the customer and reviewed by EirGrid. The selected location of the gangway landing point on the platform shall be selected to accommodate a wide range of different jack up vessels and connection bridges.

8.4.4 WALK-WAYS ROUTING & ACCESS ROUTES INDOOR OR OUTDOOR

Walk-ways and corridors can have a fundamental impact on safety during normal operations, maintenance and emergency situations. Walk-ways shall provide access throughout the platform, access to rooms, allow for transport of goods / equipment for maintenance and a means for escape. Walkways can be routed indoor and/or outdoor.

There are generally three approaches to gain access to a room, this can either be:

- From walk-way routed outside;
- From corridor routed inside;
- From another room.

As per HSE requirements each room (except for small rooms) should have as a minimum two separate means of escape.

The Customer shall propose a layout design clearly showing how all rooms and outside areas can be accessed safely during normal operational situations, for external maintenance, and in case of emergency escape.

8.4.5 Stairs

Apart from the ladder of the boat landing, and individual equipment access ladders, all access between levels shall use stairs. A minimum of two access routes using stair cases shall normally be provided, on opposite sides of the substation.

A secondary means of access can be via ladders, primary access will be via stairs.

Width and corners of stairs (between the walls or external handrails / grillage) shall be suitable to allow passage of two people carrying a stretcher.

Stairs shall consider EN14122 parts 1-4 and shall not be in contradiction with EERA study.

8.4.6 Emergency Escape Routes

The platform shall be provided with suitable and sufficient escape routes leading to the primary and secondary muster area and giving access to the means of evacuation and escape. For escape ways and routes the DNVGL ST-0145 is applicable.

8.5 Corrosion Protection System

The Customer shall provide a corrosion resistant design and apply corrosion protection systems to ensure that all components of the OSP and associated equipment supplied are adequately protected against external and internal corrosion throughout their operational life.

The following methods shall be considered for effective corrosion protection:

- Use of corrosion-resistant materials in the design
- Protective coatings
- Cathodic protection
- Isolation or segregation of dissimilar metals
- Cladding or protective wraps (if effectively sealed)
- Control of humidity and/or oxygen for internal zones

The corrosion protection systems shall be designed, planned, executed, maintained and disposed of in such a manner that they do not endanger the health and safety of the people involved and with particular attention to the following:

- Not specifying or using toxic or carcinogenic substances
- Emissions of volatile organic compounds
- Measures against harmful effects of fumes, dust, vapours and noise, as well as fire hazards
- Protection of the body, including the eyes, the skin, the ears and the respiratory system
- Protection of water and soil during corrosion protection work – Recycling of materials and waste disposal.

The overall design shall be planned to facilitate surface preparation, painting, inspection and fabric maintenance and repair, and shall consider the following:

- Avoiding the formation of corrosion footholds;
- The shapes of the structural elements and the methods used to join them should be such that fabrication, joining and any subsequent treatment will not promote corrosion; and
- Component which are no longer accessible shall be protected effectively throughout the service life.

Based on the above principles, the following recommendations should be considered in the corrosion protection design:

- The surfaces of steel structures exposed to corrosion stresses should be small in extent;
- The structure should have the smallest possible number of irregularities (e.g. overlaps, corners, edges);
- Joints in the permanent steelworks should have preferably been made by welding, rather than bolting or riveting, to achieve a smoother overall surface.
- Discontinuous welds and spot welds should only be used where the corrosion risk is negligible;
- Steel components should be designed to be accessible for the purpose of applying, inspecting and maintaining the protective paint system. ISO 12944-3 recommended minimum access dimensions and minimum dimensions for narrow spaces should be applied;
- Components which are at risk of corrosion and are inaccessible after erection should either be made of a corrosion resistant material or have a protective coating system which shall be effective throughout the service life of the structure. Alternatively, an allowance for corrosion (thicker steel) should be considered;
- Narrow gaps, blind crevices and lap joints which are potential points for corrosion attack arising from retention of moisture should be avoided and, where they cannot be avoided they should be sealed with appropriate material.
- Dirt and water traps shall be avoided by providing drain holes and/or orienting to avoid their formation;
- Weld access hole or rat holes shall be sealed from corrosion factors
- Sharp edges on the substrate should be avoided, and designed with inclined or chamfered surfaces;
- Open box members and hollow components which are exposed to surface moisture shall be provided with drain openings and effectively protected against corrosion;
- Sealed box members and sealed hollow components shall be impervious to air and moisture. For this purpose, their edges shall be sealed by means of continuous welds and any opening shall be provided with sealing covers. During the assembly of such components, care shall be taken to ensure that no water is trapped;
- Notches in stiffeners, webs or similar building components should have a radius of not less than 50 mm to allow adequate surface preparation and application of a protective paint system;
- Appropriate precautions shall be taken to prevent damage to the protective paint system during lifting, transport and on-site operations

Where materials of dissimilar electro chemical potential are used, they are insulated from each other to prevent local contact corrosion due to electrolytic action. For the purposes of this requirement, paint is not considered an electrical insulator.

The substructure/bottom topside shall have a corrosion allowance for members located in the splash zone. The corrosion allowance shall be based on the lifetime of the platform. The thickness of the corrosion allowance shall be calculated according to NORSOK M-001 [§4.5].

8.5.1 COATING

As per DNVGL-RP-0416, the coating systems can be specified according to NORSOK M-501 or ISO 12944.

Selection of coating systems must also take account of repair following damage, wear and mechanical loading which may be expected to occur during fabrication, storage, transportation, installation or operation.

8.5.2 CATHODIC PROTECTION

8.5.2.1 IMPRESSED CURRENT

As stated in DNV-ST-0145 Guidance Note under Section 4.8.8, there is at present no standard covering the detailed cathodic protection design of fixed offshore steel structures by impressed current from rectifiers. Should the Customer choose to use impressed current as part of the proposed corrosion protection design, it shall be documented that the performance, reliability, robustness, and availability of this active system is better than state-of-the-art passive corrosion protection systems. Further, the Customer must demonstrate that the system does not jeopardize the integrity of the substation structure or electrical systems. Documentation of this proof shall be forthcoming, to EirGrid's review and the proposed solution will be subject to approval by EirGrid.

8.5.3 FABRIC MAINTENANCE

Since the durability of a protective system is normally assumed to be shorter than the expected service life of the structure, additional considerations shall be given at the planning and design stage to the possibility of their maintenance or (partial or total) refurbishment. Details should be provided in the appropriate maintenance strategy for handover to EirGrid.

The durability of a protective coating system depends on several parameters, such as:

- Type of paint system;
- Design of the structure;
- Condition of the substrate before preparation;
- Surface preparation grade;
- Quality of the surface preparation work;
- Condition of any joins, edges and welds before preparation;

- Standard of the application work;
- Conditions during application;
- Exposure conditions after application.

ISO 4628, parts 1 to 6 should be used to evaluate the coating failure, and the maintenance program shall be planned accordingly.

The entire topside steelwork shall be protected by coating systems only and it should be able to be maintained by one certified system.

8.6 TOPSIDE/SUBSTRUCTURE INTERFACE

Interface elevation, i.e. the split, between topside and substructure may be strongly dependent on the installation method. EirGrid does not mandate any particular interface solution, as this will vary with the Customer’s installation method, substructure concept, contracting strategy and overall construction program.

The structural connection between the topside and substructure can be either a welded type, grouted type, bolted type or swaged type. The Customer shall take fully account of the design loading, load transfer and survival loading criteria.

8.7 CABLE DECK

In order to be less dependent on the topside fabrication and installation, and more flexible in the cable laying time schedule, a cable deck could be part of the substructure concept and thus create the possibility of pulling in cables before the topsides are installed as well as with the topside already installed. However, the Customer is free to define if the cable deck is to be part of the topside or substructure, as this ties in with the overall project-specific contracting strategy, installation vessel availabilities and construction program.

8.8 CABLE ROUTING

The Customer is to consider if junction boxes for the wind farm array cables are to be used to minimize pull-in length and routing of the array cables. Alternatively, in-line pluggable joint connections (Pfisterer or equivalent) can also be used.

Junction boxes or joints are not allowed for the export cables, as these are to be pulled directly into the switchgear.

8.9 GRILLAGE/SEA FASTENING

The Customer shall design all grillage and sea fastenings required for the OSP transport and installation.

The design shall also include grillage for the purpose of:

- Fabrication of the topside and substructure
- Offshore transportation

The Customer shall ensure the optimal design solution in accordance with the OSP topside, selected transport vessel and route.

8.10 Marking and Signage

8.10.1 Platform Seamarking

Signage shall follow consent conditions as well as national and international maritime navigation legislation, and shall include as a minimum:

- Name of the wind farm;
- Location of the OSP with coordinates; and
- Contact details of the marine operations centre and emergency response (if different).

Its location(s), size, font, illumination, colour scheme and corrosion protection shall follow the appropriate standard.

The Customer shall produce a platform navigational aid and sea marking concept both a concept as well as implementation plan and shall take into account the project lifecycle until the installation is fully operational as navigational aids set up during commissioning may be different to the operational phase. Platform's navigational aids and sea marking design shall take into account maritime legislation, geographic unique conditions being e.g., an obstruction to marine traffic as well as aviation. The concept shall take into account all geographic conditions and shall be maintained and forwarded to EirGrid for review. Such concept shall be produced by an organisation who have expertise in this field as it may require regulatory approval.

8.10.2 Platform Signage and Labelling

The signage, pictograms and labelling throughout the platform needs consent with EirGrid. The Customer is to propose along the design general labelling and signage meeting industry's general code of practice and Irish best practice including legislation consideration on safety hazard and warning pictograms.

Drawings shall be made available showing all proposed safety, escape, evacuation and work precautions pictogram and labelling and shall be part (where applicable) of the EERA including escape and evacuation labelling.

8.11 Hazardous Substances

All hazardous substances used on the platform shall be managed and contained using standard control and monitoring systems. Depending on the nature of the equipment, suitable containment systems (gas), level switches and separator tanks (oil) shall be installed to contain leaks as per relevant European regulations and standards.

Storage of hazardous substances shall be confined to areas suitably located on the platform. These areas shall be segregated at a safe distance from occupant areas, escape routes and sources of ignition.

The Customer shall declare all substances classified as hazardous material as outlined further in the EirGrid Functional Specification OFS-SSS-400.

9 Substructure

9.1 General

The following minimum design principles shall be taken into account:

- The substructure shall have adequate robustness to transfer the loads it will encounter during its design life to the seabed
- The substructure's (where applicable) pile design properties and penetration depth shall be sufficient to transfer all pile loads to the soil. For this, geotechnical studies shall be undertaken by the Customer to confirm this the outcome from such study to influence early the design accordingly
- The substructure scour protection shall be arranged in a such a way, or installed in such sequence to apply best practice or avoid deterioration or damage over the design life
- The foundation substructure shall ensure a stable and safe foundation, suitable for operation of the offshore structure, for its entire design life, up to and including its decommissioning
- The foundation's design shall limit the extent of scour, in both depth and length, so that the selected cable protection system will prevent cable damages
- The foundation scour protection shall consider cable installation access and possibilities for future cable repair

A confined space procedure and works in such environment shall undergo a HazID approach and merge into operations and maintenance manual for personnel entering such environment including the correlated risks to be considered for personnel.

Platform EERA from Section 7.3.9 and FERA and shall also consider the foundation/substructure either separately or combined but shall state interface and continuation including outside world e.g. vessel and HEMS.

9.2 Monopile Foundation ATEX Study (if applicable)

In the event Impressed Current Cathodic Protection (ICCP) system is used for the corrosion protection of the inside of a monopile foundation, an ATEX assessment by a competent gas expert is to be done as the ICCP generate gases, which may be hazardous and pose risks for explosion. Other gases may also occur such as flammable gases such as methane (CH_4) and hydrogen (H_2). Assessment to take into account the following:

- Gas concentration below airtight platform (ATP) and above ATP;
- Conclusion there would be no sources of ignition, or would only be a temporary occurrence during periods of calm weather combined with the ICCP system running at full capacity;
- Sealants are in place and are reliable to ensure that the gas remains below the platform, and;
- Considerations of confined space as personnel to go down for inspections as a minimum twice annually.

10 Substation Electrical Equipment

10.1 Integration and Connection of HV/MV/LV equipment

Before electrical outfitting can be carried out, the Customer is to prepare specific requirements for its contractors/suppliers. Outfitting plans are to be presented to EirGrid for review.

10.2 Main Power System

Requirements for the main power system are outlined in the EirGrid Specification OFS-OSP-135.

10.3 Auxiliary Power System

Requirements for the auxiliary power system are outlined in the EirGrid Specification OFS-OSP-136.

10.4 Control and Protection

Requirements for control, protection and signalling are outlined in the EirGrid Specification OFS-GEN-016.

10.5 Telecommunication Systems

Requirements for telecommunication systems are outlined in the EirGrid Specification OFS-GEN-015.

10.6 Revenue and Check Metering

Requirements for revenue and check metering are outlined in the EirGrid Specification OFS-GEN-016.

10.7 Earthing and Lightning Protection

The Customer shall design a suitable system for the earthing and lightning protection requirements of the whole OSP.

The Customer shall propose an earthing concept to ensure all electrical installation is bonded to the main earthing system. Earthing requirements for electrical systems are outlined in the EirGrid Specifications OFS-OSP-135.

The Customer is to define the number of earthing connection points for the earthing system from the OSP topside to the OSP support structure. The location of earthing connection points and fixings shall be designed with consideration given to future inspection and maintenance requirements detailed in the appropriate maintenance strategy to be handed over to EirGrid.

The lightning protection design shall be assessed, dimensioned and installed in accordance with DNV-OS-D201. The metallic structures located on the platform shall be used as part of the air termination and down conductor system.

11 Substation Utility and Safety Systems

11.1 General

The OSP support systems are required for the satisfactory operation of the installation under all normal operating, maintenance and emergency conditions.

Optimum design of the substation supporting systems shall consider the effect of failure modes (failure rate, time-to-repair, modularisation, etc.) and redundancy (N-1 contingency), particularly during periods of weather restricted access to the platform.

The scale of the design shall consider the number of components, degree of complexity and flexibility. The working life of all secondary system equipment shall be maximised to reduce the requirement for replacement during the design lifetime of the platform.

The following OSP support systems are required:

- Equipment and Material-Handling Systems;
- Heating, Cooling, Ventilation and Air-Conditioning;
- Fuel and Chemical Bunds;
- Drainage System;
- Waste Management System;
- Deck Wash System;
- CCTV and security systems;
- Marine radar transponder beacon (RACON);
- Voice communication system;
- VHF (Aviation and Marine band)
- LAN and WAN;
- Wireless LAN;
- Time synchronisation;
- Meteorological station;
- Metocean monitoring;
- OSP Fire Protection
- EER arrangement
- Life Saving Appliances, Fire Fighting Equipment and PPE including suitable arrangements for storage of equipment and necessary spares and consumables
- Door Access Control System
- Emergency Power Supply (covered in OFS-OSP-136)
- Platform lighting system for unmanned and manned and emergency modes
- Navigational aids and seamarking for marine and aviation application

The following systems are to be installed if applicable:

- Wildlife deterrent system;
- Automatic Identification System (AIS) if not part of navigational aids and seamarking concept, and;
- Marine radio;
- PAGA system;

See also OFS-GEN-015 for additional requirements regarding support systems to be interfaced with SCADA and telecommunications systems.

11.2 Material Handling

A material handling study shall be provided by the Customer in alignment with the operations and maintenance concept. This study shall regularly be revised with developing project stages. See also the material handling philosophy in section 7.3.13.

The platform layout shall cater for sufficient and unobstructed transport routes and space to handle and temporarily store materials. Objects adjacent to transport routes shall be protected from impact damage.

Minimum width and height of mechanical handling routes should correspond to the largest item to be transported along that route.

Lay-down and transfer areas shall be located on each level of the topside and substructure to allow safe transfer of equipment between relevant locations.

Laydown areas, lifting appliances, walkways, and room arrangements shall be shown on the plot plans and mechanical handling drawings. Escape routes shall be shown on safety layouts.

Topside deck levels, stores, main lay-down areas, shall be supported by mobile transfer equipment (ex. Deck trolleys, runway beams, EOT cranes, beam clamps, pad eyes etc.). Mechanical handling route shall be reinforced in line with the expected maximum weight carried on these routes.

11.2.1 Lifting Points

All lifting points and pad eyes shall be painted in accordance with the local rules and regulations. Lifting eyes must be in a different colour than other attachment points (regular or emergency)" and clearly marked with the Safe Working Load (SWL).

11.2.2 Hatches

The use of hatches for transferring the items between deck levels may be considered. If fitted, manual or including actuation, they shall be hinged and be fitted with retaining devices and catches so they can be safely held open while in use and locked closed, when not. The hatch covers shall be suitably marked and rated for laydown loads which may be applied when closed. Actuation of hatches is allowed, however, careful consideration of the maintenance required shall be made as these items may be susceptible to degradation in a marine environment when infrequently used. Drop / pick corridors between the decks, through hatches, should be wide enough to move loads vertically up or down without any impact with the hatch-side girders. Hatches exposed to the elements shall have sealants in place to avoid moisture and water ingress.

11.2.3 LAYDOWN AND LANDING AREAS

External landing and laydown areas shall be provided on the perimeter of each deck, that can be accessed by the main crane (if applicable). The preference being to use internal deck corridors to reach these landing/laydown areas, when items shall be lifted between levels. Mechanical handling corridors shall be wide enough for the movement of trolleys.

Laydown areas shall be painted and marked with the safe load handling capacities.

11.2.4 EQUIPMENT LIFTING/HANDLING ARRANGEMENTS

Permanent arrangements (e.g., Overhead runway beams, beam clamps, pad eyes, cranes, davits, and temporary lifting arrangements) shall be installed for material handling of equipment/objects > 200 kg and which require regular maintenance, if not reachable by movable lifting appliances.

See table below for minimum requirements for material handling of equipment of various sizes based on their maintenance intervals.

Table 2 Requirements for Material Handling

The minimum requirements for material handling of equipment are given in the table below. **Maintenance interval**			
Weight	**Quarterly**	**2-4 years**	**>4 years**
23 - 200 kg	A	B	C
200 kg – 3 ton	A	B	B
>3 ton	A	A	A

A	Permanent installed lifting arrangements, e.g., monorails/pad eyes.
B	A documented description (material handling report) for material handling of equipment's with use of temporary lifting equipment. The plan shall include documentation of structural capacity of all lifting points of more than 200 kg.
C	No requirements for documentation of material handling.

For handling of all materials/objects exceeding 200 kg in weight that require maintenance, permanent arrangements, like monorails or hard points shall be provided. Alternatively mobile material handling equipment shall be provided, where required.

All equipment which foreseeably may be required to be removed/replaced for routine maintenance or overhaul shall be provided with applicable lifting and handling plans, and these shall specifically relate to the material handling equipment required and/or installed.

For battery powered lifting equipment, charging facilities in compliance with sufficient ex-protection shall be provided.

All material handling systems shall be designed and certified according to Irish legislation, and EU-Machinery Directives.

11.2.5 MAIN PLATFORM CRANE

If justified by the material handling study, with due consideration to maintenance and operating cost, the platform shall be equipped with a main platform crane, designed according to EN 13852. The platform crane shall serve the purpose of loading and unloading equipment and tools to/from supply vessels, CTVs and Service Operation Vessels (SOVs) as well as handling materials and components between the decks on the platform. The capacity, usability and availability of the crane shall be aligned with requirements identified in the material handling study.

Alternatives to a main crane may be considered after material handling study has been reviewed by EirGrid and will be subject to final approval of EirGrid.

The main crane shall be load tested before sail away from fabrication yard and where deemed necessary checked offshore before first use and shall receive certification according DNV-ST-0378, Standard for Offshore and Platform Lifting Appliances. Respective stipulations for start of warranty phase and renewal of selected part should be made in the contract.

Cranes’ SWL capacity to be confirmed in material handling study.

11.2.6 DAVIT CRANE

Davit crane access shall be provided at boat landing location. Davit lifting capacity will be informed by the material handling study.

11.2.7 OVERHEAD MECHANICAL LIFTING AID ARRANGEMENT

The auxiliary transformer room (if placed indoors) and cable deck shall be equipped with runway beam arrangement. For areas with higher frequent use foreseen, electrical hoists shall be provided, or manual chains applied depending on the material handing study outcome.

Alternatively, an overhead crane type according to EN15011 can be provided.

Both for runway beams and monorail arrangement consideration shall be given to structural characteristics and the application of e.g. EN1090.

11.3 HVAC

The platform shall include a heating, ventilation and air-conditioning (HVA/C) system. Both centralised and decentralised systems are acceptable. If a centralised HVAC system is used, the Chilled Water Units will be stand-alone. The HVAC design shall be based on a comprehensive analysis of functional requirements, heat loads from various equipment and environmental conditions to sustain OSP functions and operation during all service phases.

The HVAC system shall fulfil the following tasks:

- Protect the inside from corrosive atmosphere;
- Remove heat; and
- Provide mechanical ventilation and to supply replacement air.

HVAC design features shall meet the following requirements:

Maintainability:

- Easy access of components;
- Equipment selection suitable for the marine environment;
- Equipment selection to minimize servicing and maintenance offshore; and
- Standardizing of equipment to reduce the quantity of spares on board.

Reliability:

- Equipment, piping and ducting material selection suitable for the marine environment and continuous operation, taking into consideration the station is normally unmanned and a service interval of minimum 6 months; and
- Fan vibration monitoring (included within the installation's condition monitoring package);
- Air-flow monitoring;
- Refrigerant pressure monitoring (if applicable);
- Integration with very early smoke detection, if fitted to critical electrical spaces or cabinets;
- Protection of equipment and openings to avoid snow, ice clogging or problems with birds.

Availability:

- Essential equipment shall be 100% redundant; and
- Selection of equipment suitable for the lifetime of the platform.

Environmental impact:

- Use of natural anti-freeze agent (nontoxic to the eco system);
- Efficient equipment with low power consumption; and
- Use of free-cooling option to reduce overall power consumption and equipment running hours.

Noise levels according to national laws and regulations shall be adhered to.

Operation

The HVAC system will have the following modes of operation:

- Automatic;
- Manual; and
- Emergency operation (fire and Emergency power)

In the normal situation, the system shall run in automatic operation, and, in this mode the PLC shall control and monitor the system. System statuses shall be shown on the panel of the HMI and forwarded to the SCADA. Set points can be adjusted locally on the HMI panel or remotely by the SCADA.

In manual mode, the system shall run by "hand". During this mode, control functions shall be operated from the HMI, with the PLC only monitoring the system. In case of failure the PLC shall stop the system, which shall not be overridable by hand. Remote control function, with identical interface from the platform control room and onshore control room is required. This should be detailed during the FEED and detailed engineering stage in the HVAC specification.

In the case of emergency operation (hand or auto mode), the system shall override all current operations, and the system shall run in safe mode. Interfacing with the central fire detection control panel shall be possible during an emergency.

11.4 Drain system including Oily Water Separator system

The platform shall be equipped with a drain system, capable of handling fuel-, lubricants, transformer oil (or esters, as the case may be) and water or water-glycol / water-foam mixtures e.g. from cooling, firefighting, sewage, technical and drinking water system, or mixtures thereof.

Non contaminated water shall be discharged overboard. Fluids from the inside of the platform shall be tested for contamination prior to discharge overboard. The Customer shall ensure that the design is compliant with relevant consent conditions and regulations.

A dedicated deck drain system shall be provided. All open decks shall provide sufficient slope, coaming and drains, to collect rainwater and conduct it overboard via drain lines. The design shall cater for the foreseeable precipitation based on site specific conditions. Drain lines shall be provided with removable strainers and manual closing devices. Wind pressure shall not lead to reverse flow conditions.

A dedicated condensation drain system shall be provided for equipment generating a significant amount of condensation (> 5 litres / day).

A dedicated drainage system shall be provided for the helicopter deck (if applicable). The drain system shall be equipped with a motorized 3-way valve. For normal operation this valve shall direct rainwater to an overboard drain line. If activated by the helicopter deck firefighting and detection system or manual command, the fluids (water, foam, fuel, …) shall be collected in an intermediate tank underneath the helicopter deck. This intermediate tank shall provide a normally closed connection to the drain sump tank for the disposal of fluids.

Each oil filled transformer shall be equipped with a dedicated oil collecting tray, covered with a flame retardant grating and sized to contain the entire oil filling plus expected amount of fire extinguishing agent (e.g. foam, water).

For the collection of other fluids, a drain sump tank shall be provided with sufficient size to support 3 months of unattended operation. The sizing of the drain sump tank shall cater for all types of leakage events. To reduce the capacity of the drain sump tank an oily water separator may be part of the design.

All rooms or areas that contain equipment or piping with potential for leakages shall be equipped with at least one drain sump. Drain sumps shall be connected to a drain sump tank. Each drain sump shall provide a motorised and remote controllable valve to the drain system and a level sensor, alarming the operator in the event of a leakage. This valve shall be normally closed to support the leakage detection and open automatically in the case of a leakage alarm; manual override capability for the operator shall be provided.

All areas with oil containing equipment shall be equipped with drain pans or sills to locally contain any spillage and shall be connected to the drain system.

Fluids should be drained by gravity with a sufficient drain rate to avoid consequential damage. If gravity draining is not sufficient a drain pump shall be provided. Drain pumps shall be in line rather than of the submersible type for ease of maintenance and safety of personnel.

If fitted with a discharge pump, this shall have a capacity to empty the full drain sump tank within not more than two hours.

11.5 WASTE MANAGEMENT SYSTEM

11.5.1 WASTE DISPOSAL

The platform shall be designed and operated to have zero impact on the marine environment. International and national standards pertaining to waste disposal shall be adhered to.

11.5.2 SOLID WASTE SEGREGATION

The platform shall include an area or room designated for the storage of waste produced during operational and manned periods. During hook-up and commissioning, the expectation is that waste materials would be removed directly to the JUV or W2W vessel. For the operations phase, the preference would be not to store waste on the platform. The assumption is that waste materials are segregated at source and removed by the technicians in their lifting bags or drums. Segregation shall adhere to consent conditions and relevant regulations, as well as good practice, and include as a minimum:

- Recyclable materials – ferrous and non-ferrous metals, paper, plastic, wood;
- Industrial materials – including failed / replaced components and electronics;
- Hazardous materials – chemical-laden rags, service consumables, replaced components with potentially harmful residues;
- Domestic waste (“dry”); and

- Organic waste ("wet").

Hazardous and organic materials shall be placed in leak-proof ethylene bags prior to storage.

11.6 DECK WASH SYSTEM

A high-pressure deck wash system should be provided with the purpose of cleaning open deck areas and helideck (if applicable). Both permanent and temporary deck wash systems are acceptable. For the latter, IBC or tote tanks can be transported by CTV and also refilled from CTV fresh water tanks.

For permanent systems, supply connections shall be available on all open deck areas in a way that a complete coverage can be reached within a hose length of 20 m from each supply point.

Mobile reel mounted deck wash hoses of at least 20 m x 19 mm with controllable nozzle shall be provided.

11.7 CCTV AND SECURITY SYSTEMS

See OFS-GEN-015 SCADA and Telecommunications specification for further detail.

CCTV and associated security system shall be provided for remote monitoring of:

- The Personnel (for safety reasons);
- Access ways to/from the OSP for safety/security;
- Walkways, stairways and decks for safety;
- Exposed decks for avian protection;
- Remote working locations, e.g. crane cab
- Crane operations and load handling
- Monitoring of vessel approaching the platform;
- Monitoring of equipment;
- Provide internal feeds to the NCC, onshore security stations and selected control rooms;
- Provide onward external feeds, to be specified and through security protocols, via the internet to logistics vessels, the emergency services and other authorities.

In the event of an abnormal condition on the platform, e.g. smoke / gas detection, activation of fire protection systems, plant failure, etc, an audible and visual alarm system is required to alert personnel in any accessible location on the platform.

The design of the system shall provide safety monitoring to comply with legislation enacted by the statutory authority responsible for offshore installations.

In the design and construction of the surveillance system, the reliability and availability of the system shall consider the climatic conditions envisaged.

Strategic location of CCTV surveillance cameras shall facilitate the monitoring of staff, plant and planned/unplanned vessels approaching the platform, particularly from possible threat situations where an immediate response plan can be implemented.

11.8 MISCELLANEOUS PLATFORM SUPPORT SYSTEMS

11.8.1 METEOROLOGICAL STATION

A meteorological station (“met station”) shall be provided for the continuous monitoring and logging of weather parameters. The met station shall include sensors for dry bulb temperature, air pressure, relative humidity, UV radiation, wind speed and direction.

The apparatus shall be installed in the open (above the platform), in a manner that prevents shielding by other structures or equipment, but does not interfere with the obstacle free zone for Heli-winching.

Data recorded by the met station shall be continuously logged within an accompanying software application running on a server located in the control / communications room. It shall be possible to access and download the real time and logged data remotely, via the OSP-to-shore communications link. Data storage and extraction shall be in a non-proprietary format, e.g. comma separated variables. The application shall provide a visualization screen for the display of real time data and trends.

Individual sensors shall be replaceable. The vendor shall provide a list of envisaged spare parts for five years of service.

11.8.2 METOCEAN MONITORING

In order to assist in vessel logistics and operations planning, marine rescue and recovery, and structural health monitoring of the foundation, the OSP shall be fitted with following wave monitoring facilities:

- Wave-height monitoring
- Air-gap monitoring, if this cannot be directly calculated from the wave-monitoring system
- Wave and current radar

As with the meteorological station, time series data at an appropriate frequency shall be gathered, processed and stored on data-loggers and/or a server on the OSP. This in turn shall be transmitted, following processing, via the LAN or the SCADA system, and the line of site microwave link to shore and onwards to the NCC and other control stations. Time series data shall be made available, via a secure internet or cloud-based solution to external parties, mariners, the coastguard and, when required, the emergency services. All feeds, following processing shall be displayed and visualized on software where trends, alarm levels and decision criteria may be overlaid.

11.8.3 WILDLIFE DETERRENT SYSTEM

The offshore substation shall be equipped with an adequate bird deterrent system intended to deter birds and bats. Most bird deterrent systems have several sensors or CCTV cameras using intelligent video analysis to detect incoming birds.

The following shall be considered:

- Ultrasonic generators designed to deter bats;
- Passive means of discouraging birds from nesting, such as rotating foil decoys, nets and guards;

- Cameras (or other methods) for the detection of inbound birds and initiation of active measures;
- Active means of deterring birds, such as lasers and acoustics

The following active concepts have proven most effective, and shall also be considered:

- Unexpected sounds (library of 10- 15 sounds played at random order);
- Bio-acoustic (simulating the distress call for different species); and
- Laser beams (which seeks out their spots, disturbing them visually and causing them to flee).

It shall be possible to disable active deterrent systems when the OSP is manned, or during the approach phase of a helicopter.

Deterrents based on means designed to inflict harm on animals are expressly forbidden.

11.8.4 CONDITION MONITORING

See OFS-GEN-009 for additional information. The offshore substation platform should be fitted with condition monitoring as per good industry practice and manufacturer recommendations to detect, monitor and measure events, degradation trends and damage mechanisms which will inform the planning and execution of condition-based maintenance and inspection. The Customer shall justify the inclusion/exclusion of various condition monitoring systems based on a risk assessment and cost-benefit analysis.

Such systems shall be installed to digitally record and transmit time series outputs from the installed sensors via locally installed data loggers or servers, through the LAN or SCADA system, to a data historian for processing, trending and visualisation, including dashboarding. The associated software should be configurable to allow the setting of primary and secondary alarms, and event logging.

As a minimum, the types of systems to be fitted are as follows:

Structural Monitoring

- Tilt, settlement, motion and shock;
- Wave spectrum/wave radar monitoring;
- Wave height;
- H2S monitoring (mono-pile gas tight floor);
- Acoustic event detection;
- Cathodic protection monitoring system;
- Scour monitoring system;

Thermographic Monitoring (via CCTV if possible)

- Transformer and transformer bays;
- Shunt reactors (if applicable);
- Main electrical cabinets and switchgear rooms;

Rotating Machinery Vibration Monitoring

- HVAC fans;
- Pumps;

Electrical Room and Cabinet Monitoring

- Gas Insulated Switchgear SF6 leakage;
- Very early smoke detection;
- Spark detection;

11.8.5 OTHER MISCELLANEOUS SYSTEMS

See also OFS-GEN-015 SCADA and Telecommunications Specification and OFS-OSP-136 Auxiliary Electrical Systems Specification for further miscellaneous supporting systems.

12 MECHANICAL COMPLETION, YARD INTEGRATION AND OFFSHORE COMMISSIONING

This section outlines the general commissioning and takeover requirements related to the overall OSP. Further specific commissioning and testing requirements relating to the OSP are outlined in associated specifications.

The Customer is responsible for commissioning of all elements of the transmission assets including the OCC, OSP and export cables, and for coordinating with its contractors and EirGrid during the energisation of such plant and systems.

The Customer shall develop and propose Inspection and Test Plans (ITP) and commissioning procedures for EirGrid review. Based on the ITP, EirGrid will inform the Customer which of the testing and commissioning activities EirGrid will attend.

All plant and systems shall be pre-commissioned to best industry practice, ensuring that all plant and systems are installed correctly as per design, and are functionally operational.

Everything that can be done onshore before the substation platform leaves the construction yard should be, so that those activities which can only be performed offshore are left to be completed when the platform is installed on its foundation. The onshore testing should be as comprehensive as possible to identify any problems before the substation is transported.

Furthermore, all equipment should be installed and assembled as far as possible onshore. Dismantling of any parts of the equipment for transport and the reassembling offshore should be avoided if at all possible.

The equipment shall be designed such that it can withstand the forces which it will experience when being transported to the platform. This is particularly relevant to oil filling of transformers and gassing up of GIS switchgear equipment.

Equipment which has been thoroughly tested onshore shall be subjected to the minimum offshore testing required to verify that the equipment has not been damaged in transit and that it is functioning correctly.

Certain activities such as submarine cable and fibre optic terminations will have to be performed offshore.

12.1 Mechanical Completion and Harbour Acceptance Test

Once the connections between HV/MV equipment and/or OSP-systems have been concluded, mechanical completion will be performed. The integration ends with a Harbour Acceptance Test test/check. Customer to propose HAT requirements for EirGrid review based on project specific details. The Harbour Acceptance Test includes all functional and integration testing of the systems installed on the OSP to the extent that the tests can be performed onshore. The systems that can only be tested offshore will have to be simulated as part of the Harbour Acceptance Test. This is to limit as much as possible the commissioning activities which are required offshore.

12.2 SAT and Energisation

After installation, the Customer is to conduct the following:

- Cold commissioning (no high voltage on the OSP) / start-up of all OSP-systems;
- Energization of HV/MV systems, step by step; and
- Hot commissioning, consisting of checking all readings after energization.

12.3 Protection and Metering

See OFS-GEN-016

12.4 SCADA and Telecommunication

See OFS-GEN-015.

13 Operation and Maintenance

The Customer, in consultation with their OEM's, shall list all recommended spare parts.

All recommended spare parts shall be provided with associated drawings and instructions. See OFS-GEN-009 Operation and Maintenance Specification for further detail. Documentation

13.1 DOCUMENT NUMBERING

See OFS-GEN-006.

13.2 INFORMATION AND DOCUMENT SUBMISSIONS

Document submissions are referenced in the following and in associated specifications. The documentation referenced herein is to be considered a starting point, and the Customer is to present a Master Document Register based on project specific needs and circumstances. It will be agreed during the project which documents, drawings are to be submitted to EirGrid for review or for information.

13.3 DESIGN BASIS AND DESIGN BRIEFS

See section 7.1.

13.4 CONCEPT (AND FEED) DESIGN SUBMISSIONS

For the concept design and FEED design stages, as a minimum the following documents are envisaged to be prepared by the Customer for EirGrid review:

- Project execution plan and initial master document list indicating all types of documentation to be submitted for the project.
- Design basis for structural, mechanical, HVA/C and electrical systems, including consideration of requirements regarding operation and maintenance.
- An Electrical Basis of Design for the OSP (input to the OSP design).
- A manning concept (unmanned, temporary manned, permanently manned)
- An initial fire protection concept.
- An initial explosion protection concept.
- A corrosion protection concept.
- An initial access, transfer and escape concept.
- Field layout showing helicopter approach sectors (if applicable), subsea cable routing, adjacent existing and planned installations, vessel approach sectors, crane operating ranges, scour protection (if any), area for Jack-Up-vessels.
- HAZIDs, RAMS, HAZOPs, FMECAs and FTAs for all systems
- Plot plans (conceptual).
- General arrangement/ deck layout plan (all decks and compartments, general equipment arrangement).
- Initial room list with room function, fire classification and hazardous area classification.
- Requirements for the HV systems (rooms and sizes, cables, cooling, electrical power, etc.).
- Requirements for safety earthing, lightning protection and Electro Magnetic Compatibility (EMC).
- Preliminary metocean report defining the design environmental conditions (wind, waves, current, sea ice, etc.)
- Weight estimate (with Centre of Gravity) for foundation, substructure, and topside (fully equipped).
- Preliminary in-place analysis (ULS).
- Preliminary load handling concept for main equipment (e.g. HV transformers, reactors, control and protection cabinets, gensets, aux. power transformers and

batteries) with preliminary requirements for platform cranes (number, outreach, capacity)
- Concept for platform marking and navigational aids as per authority requirements.
- Electrical load assumption for different operational modes
- Transport and installation concept
- Preliminary geotechnical design report (with reference to geotechnical site survey report and the soil and foundation expertise (preliminary))
- A foundation feasibility study containing as a minimum the following:
  - Foundation method statement
  - Description of required seabed surveys and preparation work
  - General installation steps and requirements
  - Foundation analysis
  - Pile drivability statement, if applicable (to include in preliminary geotechnical design re-port)
- Scour protection study
- Safety philosophy and objectives
- Operational Criticality Assessment

13.5 DETAILED DESIGN SUBMISSIONS

In the detailed design the full design documentation shall be completed, including as a minimum but not limited to:

- Platform operation concept
- Layout for technical and personnel rooms
- Arrangement drawings for decks showing all rooms and spaces (including open deck spaces) with their functions, together with a room list.
- Outfitting plans for all rooms
- Windows and doors plan
- Ceiling plans with ceiling heights
- Insulation plan
- Deck specific load distribution plan
- Final metocean report
- Final geotechnical design report (with reference to geotechnical site survey report and the soil and foundation expertise and with supplementary cyclical report)
- Master Equipment List (frequently updated during the design phase) with data sheets
- Load handling study
- Deck load plan including heavy load and lay down areas of all open decks
- Hook-up and commissioning concept
- Weight control report
- Global structural design analysis report for all required loading conditions (including T&I and temporary conditions)
- Detail structural analysis report for all critical areas
- Pile drivability and fatigue study (e.g. as part of geotechnical design report)
- On-bottom stability report for installation process (e.g. as part of geotechnical design report)

- Material specification
- Coating specification
- Platform dynamic analysis
- Main steel drawings for topsides, substructure, and foundation structures
- Steel drawings for mall appurtenances
- Typical welding details and node geometries
- Scouring and seabed stability reports and model tests
- Flow diagrams
- Basic design reports
- Main piping and routing layout

13.6 HANDOVER DOCUMENTATION

As a minimum, but not limited to, the following handover documentation shall be delivered by the Customer:

- Health and Safety File
- Risk Assessments
- Design Reports
- RAM(S) Report with references to all RAM(S) related workshops, studies and reviews undertaken including risk assessments
- As-built documentation, including but not limited to:
    - General layout and arrangement drawings
    - Structural elevations
    - Schematics, drawings and diagrams
    - Wiring diagrams
    - Fire control and safety plan, Escape route plan, Plot plans/General arrangement plans, Lighting plan, etc.
    - Load balance of electrical consumers, heat balance for the cooling system
    - Piping and cable diagrams (including P&IDs, SLDs, etc.)
    - Detailed design drawings
    - Equipment lists
- Specifications, materials and calculations
- Software including models and raw files from modelling
- Drawings and 3D models
- Component and material data sheets
- Manufacturing records, component quality inspection checklists, test reports and certificates
- Construction, installation and commissioning records
- Detailed T&I procedures including HAZID study, safety and emergency procedures
    - Related calculations and drawings to prove the structural integrity and stability of each phase of the operation and to confirm the contractually agreed weather limits.
    - Piling noise reduction calculations and procedures, if applicable
- Fabrication drawings
- Fabrication records (e.g. NDT records, non-conformances records)
- Test reports and certificates
- Pre-energisation check lists

- Operation and maintenance manuals and data sheets for all equipment
- Priced catalogue of spare parts and consumables, including lead times and a proposed spare parts holding for the first 5 years of operation.

The Customer shall organise the above documentation into 2 main sections:

1. Design, Fabrication and Installation (DFI) summary, i.e. all the documentation created up to the point of handover including the fabrication records;
2. Operationally critical documentation, i.e. the documentation required to operate, maintain and inspect the facility safely throughout its life.

The as-built documentation shall be available in hardcopy and electronic editable form (file-format to be agreed).

Operation and maintenance manuals shall be prepared and submitted for all platform systems covering at least the following information:

- Safety information
- Contacts for suppliers
- List of all reference documents
- Description of the system including its technical process, functional groups, control philosophy, interfaces to other systems, the location of components, etc.
- Operation of the system covering trial operation, manned operation, unmanned operation, start-up / shut-down.
- Fault finding and remedies
- Inspection and maintenance, including system preparation for maintenance
- Lists of consumables, spares and components.

The operation and maintenance manuals are to be specifically written for the actual system; all generic maker information must be suitably adapted. The preparation of the manuals shall be done by experts who are fully fluent in the English language.

Format and content of the manuals are to be agreed with EirGrid before the beginning of manual production.