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Offshore Substation (OSS) Topside Technical Specification
C256-EQ-Z-SP-00009

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1 Introduction

1.1 Objective and target group

This document targets all personnel that shall do work, follow-up deliveries or provide equipment/systems to the two, completely segregated, MWF Bałtyk II & MWF Bałtyk III offshore substations.

The objective of this specification is to detail the functional and technical requirements for the MFW (BII) and MFW (BIII) OSS topsides. The Offshore Substation (OSS) Substructure Technical Specification can be found in /4/.

This specification shall be read in conjunction with all the the Project Specific technical requirements listed in Appendix E.

The MFW Bałtyk II and MFW Bałtyk III Design Basis **Error! Reference source not found.**, set the design premises and principles for developing the OSS.

The design shall incorporate Operations and Maintenance Requirements /20/ where applicable to the OSS. Any conflict between these requirements and other specifications/standards or industry best practice shall be highlighted for Company review.

The design of the OSS shall adhere to Polish rules and regulations. If conflict: Polish rules and regulations shall prevail.

The design of the OSS shall be based on DNV-ST-0145; Offshore substations /2/ including references to other standards and guidelines, and shall be used to supplement gaps in the Polish rules and regulations where relevant. The technical requirements herein shall complement with /2/, and if in conflict, the Contractor shall inform Company.

2 Main Design Criteria

2.1 General

The OSS topside shall be designed as one unit to be fully assembled and pre-commissioned at onshore yard as far as reasonably practical.

The design shall facilitate all foreseeable work in a safe and efficient manner covering all phases.

The general design is described by the following:

- Normally unmanned platform
- Enclosed platform design – minimize amount of equipment located outdoor
- Safe and efficient design
- Integrated remote control and monitoring including condition monitoring of all main equipment
- Minimize environmental impact through all phases and lifetime of plant
- Facilitate for night shift work and during cold periods
- Access/egress via Crew Transfer Vessel (CTV), Service Operation Vessel (SOV) and Jack-up Rig (JUR)
- Secondary escape via helicopter winching and tertiary via chute/raft.

All platform services and utilities which impact the availability of the transmission system, through failure or maintenance, shall be designed with redundancy.

2.2 Personnel on board (POB)

The POB for the offshore substation shall be optimized through all phases of the plant targeting 12 POB during operational phase and 24 POB during hook-up, commissioning and initial operation phase. In addition, there shall be extra safety equipment for 12 persons (total of 36 persons) on board during the hook-up, commissioning and initial operation phase. The target of 12 POB in operational phase is dependent on the number of subsuppliers being introduced in the EPC process. The design maintenance requirements will drive manning levels.

The final optimized POB for the individual phases shall be agreed with Company.

Additional equipment and facilities may be brought onboard to increase the POB during campaigns and temporary phases to minimize the design POB.

2.3 Safe and efficient design

The offshore substation shall achieve a safe and efficient design to ensure maintenance and operation friendliness by:

- selecting concepts requiring minimum amount of topside equipment and man-hours for maintenance
- selecting equipment with high quality in materials, high durability and low maintenance requirements with proven track record for similar use in offshore applications
- designing systems with redundancy to minimize consequence of failures and maintenance without impacting plant availability
- designing systems such that faults do not need rectification until next planned maintenance visit and repair/maintenance of equipment or system does not interfere with other equipment or systems
- utilizing condition monitoring systems, remote testing and/or additional sensors/signals where practically possible to increase availability and reduce required man-hours offshore
- ensuring remote testing and remote control from onshore Central Control Room (CCR) can be performed without risk of causing any disturbance in operation or loss of plant availability
- minimize requirement for enhanced training of maintenance personnel. This entails:
    - aim to design systems and select equipment that does not require special training/certification to perform maintenance or repair
    - material handling design which minimize use of main platform crane
    - minimize requirement for tools/equipment that require special training/certification
- considering climatic conditions to ensure operability all year, by appropriate level of winterisation and protection against adverse weather
- selecting concepts and plant design to accommodate an efficient and safe decommissioning at end-of-life

Refer to safety strategy for risk mitigation and safety barriers requirements, /17/.

2.4 Maintenance philosophy

The maintenance shall guarantee safe and operable equipment, achieve legislative compliance, ensure equipment integrity and maintain equipment warranty. Effective maintenance relies on carrying out the right maintenance, at the right time, for the right cost and with the right resources.

The wind farm shall be routinely maintained by utilising a Crew Transfer Vessel (CTV), with the future possible use of a Service Operations Vessel (SOV) for campaign-based inspection and maintenance. Winching of personnel to/from the OSS with helicopter, in case of emergency, shall be facilitated.

High frequency maintenance activities (e.g. monthly, quarterly) shall be avoided, with the aim of no more than 12-month maintenance frequencies. The exception to this shall be when relevant laws and regulations require more frequent inspections. Outages impacting transmission system availability shall be no more frequent than once every 3 years.

Sufficient redundancy and durability of equipment shall be designed into systems to maximise availability and minimise unplanned visits, with the aim that common faults do not require rectification until the planned annual/3 yearly maintenance visit (as applicable).

Where temporary equipment is required for any routine maintenance, it shall be clearly defined and specified in relevant documentation. The most practical, safe and cost-efficient solutions shall be considered when it comes to if temporary equipment and tools shall be brought from shore or installed/stored offshore.

3 SSU

3.1 Working environment

For general requirements for working environment, reference is made to /15/.

3.1.1 Access

All equipment and areas shall have safe and efficient access for plant operations and maintenance in accordance with ISO 14122:2016, parts 1-4 /11/.

In addition to this:

- Protruding objects shall be avoided in walkways, access ways, escape routes and transportation ways
- Walkways, access ways, escape routes, transportation ways, laydown areas, plated decks and workspaces shall have anti slip surfaces
- Risk for falling ice and falling snow shall be assessed for work areas, access ways, transportation ways and escape ways and if necessary, mitigating actions shall be implemented.
- Where possible, the platform design shall avoid steps and ladders to create a step-less working environment. Door thresholds shall be removable if used
- Stairs shall be used when possible, instead of ladders
- Manholes and confined spaces shall be avoided where practically possible
- No areas are allowed where rescue-up is the only evacuation strategy
- Location of equipment and instruments to be carefully chosen to enable safe and efficient maintenance:
    - Visual displays, gauges, level glasses etc. shall be easy to read from ground level

- Access to perform maintenance and inspections shall be possible from ground level or with suitable fixed access method. Where this is not practical or possible Company shall be consulted
- Access to operate equipment shall be from ground level or with permanent access platform
- Requirement to use scaffolding for access is not accepted for regular maintenance activities
- No offboard access needs or working at height close to platform edges triggering need for man-overboard stand-by vessel. Where this is not practical or possible Company shall be consulted
- The operators reach to equipment shall be <= 500 mm
- At work position, ensure a 700 mm clearance for working (maintenance space)

- It shall be possible to operate outdoor handles, switches etc. while wearing gloves
- In case scaffolding or other temporary aids are needed either during hook-up or planned maintenance, support brackets / attachment points on the structure shall be included as required

3.1.2 Fall Protection System

General

Fall protection systems shall cover the complete topside and substructure through all phases ensuring the personnel are always protected from falling from any height. This includes also local fall protection systems on equipment and structures where access is required to operate equipment or perform planned maintenance.

Selected fall protection systems shall be reported to and agreed with Company in early design stage to enable Company to standardize.

In the boat landing access area, special considerations shall be given to the design of handrails and stanchions in order to support fall arrest system and anchor points. Extent of this additional requirement is based on the design where further recommendation from the designer is expected.

All connections between elements shall be securely fixed by lock nuts and through bolts, or self-tapping screws. Setscrew type connections are not acceptable as permanent fixing method. The fixed connections shall not loosen or weaken by normal use, wind or platform vibrations.

Handrails and guardrails, stairs and ladders

All handrails and guardrails shall be solidly designed for personnel protection and shall resist the accidental impact of a falling person, in any direction and at any point.

The installed hand and guardrail system and stairs and ladders, complete with all its parts and fixing details, shall be maintenance free. Secondary retention (such as double nuts etc) shall be considered for all fixings where possible. Materials shall be in accordance with the materials selection philosophy, /7/.

The multi-barrier principle shall apply for the complete hand and guardrail system and stairs and ladders, where a single fault shall not cause a system failure. Any weaknesses or faults developed over time shall be detectable by visual inspection.

Caged ladders (ladders with back scratcher) shall not be used. Other types of fall arrest systems shall be used.

Inclined ladders should be avoided.

Fall arrest system

Each OSS shall be equipped with sufficient fall arrest systems.

The mounting location of the fall arrest system shall ensure suitable access for installation and maintenance purposes of these systems. The equipment shall be located high enough to reduce the possibility of collision with personnel when connecting/disconnecting from the system.

All fall arrest systems shall be certified for outdoor use and storage (marine environment).

The rescue and evacuation systems (descender devices for rescue) and Fall Arrest Self Retracting LifeLines shall be delivered according to the relevant standard.

External fall arrest tether line systems should be of simple type, with all units on ladders to sea with a weak link between tether line and fall arrest device. Bottom bracket for tether line system should be at Highest Astronomical Tide (HAT) line.

For all relevant areas where a fall prevention system is not practical and a fall arrest system shall be used, it shall be assessed whether a permanent device or an anchor point for a device shall be made.

Anchor points

Suitable rescue device anchor points shall be above all fall arrest devices and attachment points.
The anchor point of the fall arrest system at the upper section of the ladder shall be made of coated stainless steel to avoid corrosion happening as a result of coating damage when servicing the system.

Where possible, anchor points shall be designed to always allow for the lowest fall factor.

Anchoring points shall be located on locations where the danger of falling exists and no guard-rail can be constructed (e.g. a hatch or gate-opening, a platform, a ladder end).

The location of the anchor points shall consider the positions that personnel are required to stand in order to stabilize loads, the maximum length of fall arrest lanyard, and the anchor point is required to be of suitable dimension to allow a hook to be connected.

Fall arrest equipment and systems shall be of modular design to allow for offshore maintenance and certification.

Guidance note: Anchor point: point on an anchor device or structural anchor used for the connection of personal fall protection equipment

Anchor lanyard: lanyard connected to the main attachment point of the harness, which normally incorporates a connector, and which is used for connection to an anchor point NOTE Some anchor lanyards are also known as cow's tails

3.1.3 Welfare and emergency accommodation facilities

A multi-purpose area shall be available at suitable location on the lowest topside deck to house the required welfare and emergency accommodation facilities for personnel working on the OSS.

The multi-purpose area shall be a single enclosed area with internal divisions to create separate rooms to accommodate the different functions and facilities required in suitable spaces for the intended uses and applications.

The multi-purpose area shall be designed as a manned area.

The multi-purpose area shall contain the following functions and facilities:

- Changing area including personal lockers
- Primary muster area

- Emergency overnight shelter
- Resting/eating area with pantry
- Office/workstation facilities
- Storage facility for emergency, escape and rescue equipment
- Separate area to facilitate toilets with air extraction units

The multi-purpose area shall minimum contain the following equipment:

- Personal lockers and bench area for POB
- Table with chairs for POB, including sockets for personal laptops
- Pantry including: (with timer on electric appliances):
    - Microwave
    - Electric kettle
    - Facility for hand wash
    - Cupboard
    - Trash can
- **Floor space** for emergency overnight shelter for POB
- **Storage facilities** for emergency, escape and rescue equipment, including:
    - Two (2) incinerated toilets
    - Emergency shower
    - Sleeping bags, sleeping pads, dry provision, and bottled water for POB for 5 days
    - Other miscellaneous safety and first aid equipment ref 3.3.1
- Two (2) foldable bedsCommunication facilities, such as VHF station, IP telephony, fixed UHF-radio
- Slave Fire Detection (FiDe) and Fire fighting (FiFi) control panel
- One Electrical System Interface (ESI) SCADA workstation, one Wind Turbine Generator (WTG) SCADA workstation and one engineering workstation

The layout design of the multi-purpose area shall consider the locker/changing room area as a wet area designated as the main entrance separated from the other rooms with internal doors. This is to split the area into a dirty and a clean zone and to function as an “airlock” for the office/welfare area to external environments.

The locker/changing room area shall be designated as the primary muster area.

3.1.4 Hazardous chemicals

Exhaust outlets and vents containing hazardous components shall be designed to prevent contamination into air inlets and work areas.

A permanently installed cabinet shall be located at suitable location outdoors to enable temporary storage of hazardous chemicals.

Use of chemicals and articles in design and operation shall comply with Company technical requirements provided in TR1668 Prohibited and Restricted Chemicals /16/.

3.1.5 Noise and vibrations

Noise and vibration levels shall comply with relevant Polish authority requirements and the Company upper area noise limits are given in Table 1 (the stricter requirement prevails).

Table 1. Company Area Noise Limits (TR0926)

Area / activity	Area noise limit, dB(A) (Incl. structural induced noise)
Unmanned machinery rooms **where stays involve brief inspections only**	110
Main equipment rooms & utility areas	85
Outdoor muster & lay down areas	75
Light industry work, workshop	65
Administrative spaces, multipurpose area,	55
Location: At a distance of 1 m from each item of plant or its acoustic enclosure and at 1.2 m above the floor level, or elevated platform.	

Areas with noise levels exceeding 80 dB(A) or 124 dB(C) peak shall be marked with warning signs.

3.1.6 Hot and cold surfaces

Working areas, ladders, stairs, and access routes shall be placed or protected such that contact with piping and equipment surfaces with a temperature above +60°C or below -10°C is avoided.

3.1.7 Illumination

Two operating modes for lighting shall be provided: Manned and unmanned. Reference is made to chapter 6.11.

The work area light intensity shall be adequate for the general purpose of the location and type of activity when the platform is manned. Illumination shall comply with relevant Polish authority requirements and the Company illumination levels given in Table 2 (the stricter requirement prevails).

Suitable design measures need to be implemented to prevent or reduce unnecessary light emissions.

Table 2. Company minimum illumination requirements (TR0926)

Type of work	Average lux
Outdoor non work	20
Simple orientation, temporary visits	50
Occasional visual tasks only	100
Medium precision work	200
Precision work	500

The lighting of areas monitored by closed-circuit television (CCTV) equipment shall be sufficient and ensure efficient operations. The sensitivity and technical specifications of the CCTV equipment shall be considered in the lighting design.

Non-ionizing radiation doses shall be kept as low as reasonably practicable. Exposure levels of non-ionizing radiation shall comply with Polish requirements and shall not exceed the “ICNIRP Basic Restrictions and Reference Levels for occupational and general public exposure”.

The design should minimize exposure to electromagnetic field (EMF) and areas where levels are above reference levels for general public exposure shall be marked with warning signs.

3.1.8 Biological hazard control

Biologically contaminated waste material (organic waste, medical waste, sewage, drain) shall be contained and kept in closed systems.

3.2 Technical Safety

For technical safety requirements and description of need and role of safety barriers it is referred to the safety strategy for offshore substation MFW & MFW , ref. /17/.

3.2.1 Design accidental loads

A design accidental load report shall be based on risk analysis and guidance provided below in Table 3. Additional accidental loads shall be identified by risk assessment.

Table 3. Design accidental loads

Design accidental load	Guidance
Fire loads on loadbearing structures	Fire load scenarios for high voltage (HV) electrical equipment shall be based on input from supplier. See safety strategy /17/, for guidance regarding oil filled transformers.
Explosion	The structure shall be designed for relevant explosion loads. See safety strategy /17/, for guidance regarding oil filled transformers.
Dropped object loads	All structures in lifting routes and defined laydown areas shall be designed for dropped objects. These loads must reflect planned material handling at or above the platform, if lifting restrictions are not implemented. Deck structures above transformers, generator and diesel tank shall be designed to withstand dropped objects. Design impact load to be determined based on material handling study.
Swinging objects loads	Swinging load protection must be implemented as required to prevent impact to critical equipment and critical damage to load bearing structures. This is relevant in all foreseeable lifting zones from cranes on the OSS and use of SOV gangway and, if equipped, gangway associated crane. For structures and equipment, the design load for swinging object loads shall be based on material handling study.

Ship collision	See safety strategy /17/

3.2.2 Functional safety management

Availability and reliability requirements for components used as part of instrumented safety barriers shall be as follows:
Predefined minimum performance level (SIL) for the components, part of instrumented safety barriers, shall be as provided in Table 1, when used to protect against severe safety, environment and/or business loss/asset consequence. The requirements are limited to the components, and not to the entire functions.
All components used in the instrumented safety barriers defined in Table 1 shall be certified in accordance with IEC 61508 or “proven in use” as described in IEC 61508-2, clause 7.4.10.
For machinery safety functions shall be compliant with relevant IEC standards e.g. IEC 62061 "Safety of machinery: Functional safety of electrical, electronic and programmable electronic control systems".
The applicable safety system, or affected parts of it, shall be designed to fail-to-safe principle, whereby the system goes to a predefined safe state in the event of detectable malfunction. If it is not feasible to implement a fail-to-safe principle, an equivalent level of safety shall be achieved by redundancy and/or diagnostics and fault alarm to the control room.
The probability of single defects / failures causing inadvertent trip actions shall be as low as reasonably practicable
All barriers or parts thereof, shall be protected against environmental conditions that may compromise their safety functions, e.g. ice, snow, sand, water, etc

Table 1: SIL guidance for typical components used as instrumented safety barriers relevant for offshore wind

Performance standard	**Component**	**SIL**	**Functional boundaries / comments**
PS 2 – Natural ventilation and HVAC	Fire damper	SIL 2	When used to prevent ingress or spreading of gas or smoke
PS 3 – leak detection	SF6 gas detector	SIL 2	When used for protection against asphyxiation.
	Flammable fluid gas detection (HC, etc.)	SIL 2	
	H2 detector	SIL 2	When installed and used in battery or hypochlorite rooms to prevent explosive atmosphere
PS 4 – Emergency shutdown (ESD)	Shut off valves (flammable/toxic medium)	SIL 1	The SIL requirement applies only to valves protecting against severe safety, environment and/or asset consequences or preventing escalation, and includes: - Solenoid - Actuator - Valve body

	ESD push buttons/switch	SIL 1	
Overall	Safety logic solver (excluding IEDs)	SIL 2	Requirement applies to input & output cards, and CPU. System safety manual shall provide guidance to applications and application program development.
PS 7 – Fire detection	Smoke detector	SIL 2	
	Flame detector	SIL 2	
	Heat detector	SIL 2	
	Multi detectors	SIL 2	
PS 9: Active fire protection	Nitrogen release valve (water mist)	SIL 2	
	Pressure regulating valve (water mist)	SIL 2	
	Water mist zone valves (incl. solenoid)	SIL 2	
	Inergen release valve	SIL 2	
	Foam release valve	SIL 2	

3.3 Evacuation

Requirements for evacuation systems are provided in safety strategy /17/.

An escape chute solution and liferaft(s) shall be included on two separate locations of the platform to maximize availability. See Figure 1. Example of escape chute arrangement for example used on another installation.

Figure 1. Example of escape chute arrangement

A helicopter winching area shall be provided on the top deck, properly marked with text, symbols and aviation lighting according to relevant Polish rules and regulations. There shall be no obstructions such as antennas, masts or other equipment preventing helicopter access above the winching area. Polish regulations shall be followed, and this is assumed to be a maximum helicopter rotor diameter size of 17.2 m (Sikorsky S92 with D-value = 20.9 m).

The boat landing ladder(s) shall also be utilized as escape to sea ladder(s). Minimum one escape to sea ladder shall be available in all operational modes, including during temporary phases with flotel/JUR operation.

3.3.1 Safety equipment / first aid equipment

Miscellaneous safety equipment types, locations and quantities shall as a minimum be selected with respect to the following requirements and be approved by Company:

- Appendix E
- Medical needs analysis
- Escape, Evacuation and Rescue (EER)

Safety equipment shall be of an appropriate rating designed for offshore use and shall be stored on the OSS in line with manufacturer instructions.

Outdoor located safety equipment shall be climate protected if required.

Safety showers shall be of portable type, selcontained with respect to water and pressure, and stored in frost protected area.

See further requirements to safety and first aid equipment in safety strategy /17/.

3.3.2 Signage and identification systems

ID, signage, marking and illumination of signage/markings shall be in accordance with Polish laws, rules and regulations. Text on safety signs shall be dual language, Polish and English language.

See further requirements to safety signs and markings in safety strategy /17/.

For all electrical breakers arc flash levels need to be clearly stated next to the breaker.

3.4 Environment

Reference to appendix E for environmental requirements. To further emphasize:

Air Emissions

Air emissions shall comply with relevant EU and Polish rules and regulations.

Diesel generator air emissions shall comply with Polish regulations. The diesel generator shall meet the emission standard for emergency use.

Discharge to sea

Discharge from drain system from areas with potential hazardous leaks sources shall comply with Polish regulations. Effluent to sea shall be controlled and monitored such that the oil content without dilution is less than 15 parts per million (ppm).

4 Platform Utility Systems

4.1 Drain systems

General

Drain systems and/or containment shall be provided to contain and collect spills and leaks in all areas that have a source of flammable or environmentally hazardous liquid.

Drain system with direct discharge to sea shall be provided for other external areas for drainage of rainwater.

Areas provided with drain connections with direct discharge to sea, areas provided with oily water drain connections and areas provided without drain connections shall be clearly documented in relevant documentation.

Drain systems shall be segregated. Drains which can be expected to only receive rainwater shall be segregated from drains where flammable or environmentally hazardous liquid can be expected. Drain from areas with flammable or environmentally hazardous liquids shall be routed via an oil-water separator.

Drain systems shall be designed such that it is not possible to transfer liquid from one drain area to another (e.g. back-flow from A system to B system).

The drain systems shall maintain operability in cold conditions and not become damaged in case of freezing during a long power outage. Use of heat tracing shall be used where there is a risk of standing water and to ensure availability of valves in the drain systems. Heat tracing shall be of self-limiting/self-regulating type, designed and installed per IEC 61892-1:2019 and TR3023.

The drain systems shall be self-draining by gravity with no pockets.

The drain systems shall have capacity to handle the scenario with the largest foreseeable volumetric liquid flow in all drain areas. It shall be done individual assessments for all areas to evaluate which scenarios these are. When evaluating the maximum potential for rainwater into drain systems, this shall be evaluated as the heaviest rainfall of 1-hour duration over a 10-year recurrence period.

Drain systems shall be designed with slope, in accordance with NORSOK P-002, section 7.2.5.1

In cases where rodding out through drain boxes is not possible, or the location or number of drain boxes does not provide full coverage, separate rod out points shall be provided.

All discharges from the drain systems shall be in compliance with Polish requirements.

The drain system, such as drain box and piping, shall not impair the integrity of fire partitions.

The design pressure of system shall be 16 barg for entire system. Drain tanks and oil-water separators can have atmospheric pressure, but shall then have vent and overflow lines without any restriction (e.g. no manual valves etc.). The vent shall be sized according to maximum inflow and outflow of the tank. The overflow shall be sized according to the maximum inflow. If these requirements are not fulfilled, the tanks/separators must have 16 barg

design pressure. Test pressure of the system (except drain tank and separators which fulfils the requirements for atmospheric design pressure) shall be 30 barg.

The drain lines shall be designed to drain large leak (rupture scenario) from the source within 10 min (or less) to drain tank. Drain tank tank shall be equipped with level measurement giving alarm on low and high level.

In case of rupture of transformers/transformer coolers, the cooling oil into the drain lines can act as a oil slug. The drain lines shall be supported accordingly.

The drain lines from source to drain tank shall be without any restrictions (e.g. valves).

Drain tank tank shall be designed to facilitate inspection and can be emptied when required. A detail procedure shall be provided for these activities in the relevant system and operation document (SO document).

The drain tank and the water/oil separator shall include dip pipes with open ends below lowest liquid level, for all inlet lines. The dip pipes shall be sufficient supported inside the tank.

If the sump tank heater(s) have a design that requires a pocket / stiffening structure inside the sump tank, this structure shall be sufficient supported inside the tank.

Tank heaters shall be retrievable without entering the tanks.

The drain system functionality shall be tested and verified.

Drain system with direct discharge to sea

The drain system boundaries are set from the drain boxes to discharge piping to sea.

The design intention for the drain system is to collect rainwater and condensation water from plated decks and discharge to sea. There shall be no areas with risk of standing water not entering the drain system. For roof deck, this could be achieved by utilizing sloped deck to either side and gutters.

HVAC room 1 & 2 shall be designed with decks drainboxes discharging to sea.

The drain pipes with discharge to sea shall be terminated on a lower elevation than the cable deck.

Drain system in areas with source of flammable or environmentally hazardous liquid

Drainage within the transformer and transformer cooler areas shall be through drip trays with fire protection grating (restricting air to burning liquids and to extinguish fire).

The drain from each external cooler area and other areas with hazardous liquids, shall be routed through an oil/water separator and to a drain tank. The drain tank and separator shall not require maintenance with entering for less than 3 year intervals.

Any discharge to sea shall comply with Polish rules and regulations

It shall be possible to drain the drain tank to a SOV or CTV via an offloading system. The system design shall incorporate required valves and connections to facilitate this. If a pump is incorporated to empty the tank, there shall be controls protecting against hazards introduced with dry-running of the pump.

Design of the auxiliary diesel engine skid and storage shall preferably be such that potential leak sources are contained within the skid in a volume not exposed to rainwater and with capacity for the maximum diesel leak inventory.

The hose reel station is envisaged to be located at low level on the platform and provided with bunding with minimum capacity to contain possible flow back diesel inventory in piping or hoses and credible pressurized leak before SOV or CTV supply pump is stopped.

In other areas where only limited spills are expected, manual collection of spills by drip trays may also be accepted. This is to be approved by Company.

System for draining diesel tank, oil filled equipment and for collecting accidental spill during maintenance or other events such as pipe rupture shall be accommodated.

If oil-in-water analyzers are used to ensure emission control, there shall be a redundant set of analysers (i.e. two or more different analyzers). The selected analyzers shall be tested over a duration of 2 to 3 months (or agreed with company) to verify that they measure correct PPM value, prior to installation. The test shall include all relevant fluid types.

4.2 Cleaning Water System

The platform shall be equipped with a system providing cleaning water for cleaning of external areas and, if required, any maintenance tasks. Water condensing in the HVAC system shall be collected and used as the cleaning water. There shall be drip trays below the main air handling units leading the condensed water to a permanent cleaning water tank where the water accumulates continuously.There shall be a permanent cleaning water pump pumping the water through fixed piping to outlets on each deck level. There shall be controls protecting against hazards introduced with dry-running of the pump. If any deck area cannot be reached with 35 m flexible hose, additional outlets at each level are required. Portable pressure washers shall be connected to the outlets for the cleaning purposes. The pressure delivered by the cleaning water pump shall match the required inlet pressure of the pressure washers. High pressure washer shall have a outlet pressure of minimum 180 barg.

There shall be one pressure washer dedicated for and stored at each deck. The system shall have capacity for having at least two pressure washers in operation simultaneously.

The cleaning water tank shall have an overflow and vent to safe location without any restrictions. The vent shall be sized according to maximum inflow and outflow of the tank. The overflow shall be sized according to the maximum inflow.

The design pressure for the system shall be 16 barg for the entire system except for the cleaning water tank which can have atmospheric pressure as it is provided with separate vent and overflow lines with no restrictions. Test pressure of the system (except cleaning water tank which fulfils the requirements for atmospheric pressure as design pressure) shall be 30 barg.

The system shall be winterized to avoid freezing water in any places. The pressure washers shall heat the water sufficiently to eliminate hazards related to legionella.

There shall be no local low points in the supply or distribution pipes to the outlets on each deck, unless drainpoint is provided.

There shall be a sampling point in the system to check the water quality in the tank.

The design of the system shall also enable manual filling of the cleaning water tank from tote tanks.

The top plate of the tank shall have slope to avoid standing water on top of it.

4.3 Heating, Ventilation and Air Conditioning (HVAC)

4.3.1 General

The HVAC Systems shall be of industrial offshore quality with low maintenance requirements.

Modular and/or interchangeable components shall be used where practicable.

Ventilation systems that cause loss of vital platform safety functions or vital production capacity upon failure, shall be equipped with a stand-by arrangement. If one system fails or is taken out of service for maintenance/repair, the remaining system shall have capacity to maintain the system`s safety and operational function. Control systems for these services shall have redundancy. The main/standby system shall be automatically cycled on a configurable timer.

The number of sensitive controls and shutdown functions shall be minimized.

All rooms on topside shall be mechanically ventilated with a recirculation system with partial fresh air and bleed-off to ambient, or with a mechanical supply and mechanical extract system.

Transformer rooms shall be naturally ventilated. The air inlet/outlet louvres shall be positioned to facilitate cross flow natural ventilation. Louvers shall be designed to match the design life of plant. The louvers shall have vertical blades. The natural ventilation shall be sufficient to cool the transformer room in all ambient conditions. CFD simulation shall be used to confirm the feasibility of the solution.

Use of waste heat recovery is acceptable, but not required, to achieve optimal design.

The HVAC supply must be carefully designed to not use air from the exhaust of diesel generator or exhaust from supply vessels.

An air inlet section shall be installed as first measure to avoid water entrainment in the air intakes. The air inlet shall have a filter section of filter class ePM10 50%. The air filter shall provide the final protection against intrusion of sea spray, rain, snow, fog and mist (downstream of the high efficiency louver) for fresh air intakes serving mechanically ventilated areas.

The bottom wet sections downstream louver and upstream and downstream of air filter shall be sloped to internal drainage point. A perforated plate shall be installed in front of the air intakes. The plate shall be 50% perforated, and be located at a minimum distance of 1 meter in front of the air intakes.

Fire dampers shall be actuated and fail-safe to closed position. To avoid shutdown due to loss of ventilation the dampers shall be fully redundant or of a split type – meaning that ventilation can still be maintained if part of the damper fails (50% opening).

In event of fire the fire dampers shall close, and seal affected room(s) - i.e. no smoke ventilation – unless relevant Polish authority requirements require otherwise.

In event of loss of auxiliary power and subsequent loss of HVACsystem, all dampers shall close to seal all rooms.

Number of actuated dampers shall be optimized to reduce maintenance scope.

Rooms protected by inert gas fire fighting systems shall have pressure relief dampers to ambient. Dampers controlled by magnetic holding device are preferred. The HVAC system, ducting and room shall be dimensioned and sized according to maximum lateral pressure and flow requirements.

All fans shall be direct driven (impeller directly on motor). Main fans and fans in auxiliary air handling units shall have variable speed drive (VSD) control. All fan motors except for emergency fans shall have vibration sensors for drive and non-drive end, and temperature sensors for monitoring of bearing temperature.

To ensure a robust supply and extract system toward ambient wind conditions the fans shall provide 10 % extra flow capacity compared to design air flow calculations, i.e. 20 % extra fan pressure and 30 % extra motor power.

Battery room ventilation shall be covered by the normal supply system, but with separate mechanical extraction if required by battery type or Polish regulations.

The duration of OSS in uninterruptible power supply (UPS) mode shall be accounted for, and the temperature rise in all rooms/areas shall be considered. If there is a risk the temperature in a room/area goes beyond the equipment limitations within 3 hours, mitigation actions are required. The following mitigation strategy may be used:

- A UPS powered fan to exchange air with adjacent room/area, or
- If no adjacent areas are viable, a UPS powered fan exchanging air with ambient.

The latest technology in green refrigerants shall be used for design of the cooling systems. The design and construction of the refrigeration system shall require as little refrigeration filling as possible. The system shall be built for redundancy so that maintenance switchover and leak tight testing can be accomplished.

Refrigerant medium shall be natural with low GWP.

Heat tracing shall be used where required to ensure availability of HVAC system.

4.3.2 Control of HVAC

The HVAC control logic shall be implemented in a dedicated PLC with agreed communication protocol to ESI SCADA. The PLC shall be standardized, i.e use of same brand and type as for Onshore substation and to be approved by . Required communication port for management network shall be included. The HVACcontroller shall comply with applicable parts in TR TR4031. Any deviation shall be highlighted to Company for evaluation and/or approvals. The control application software shall comply with IEC 61131-3 Function Block Diagram as defined in TR4031.

ESI SCADA shall monitor and control:

- Temperature control of heaters/coolers
- Selected rooms shall have pressure, temperature and humidity sensors. Each room shall have upper and lower limit alarms and displayed in a layout-oriented HMI
- Duty stand-by equipment shall have automatic changeover once a week
- Contractor shall create an automated sequence of opening and closing fire dampers. Opening and closing times of dampers shall be recorded and presented graphically with a trend displaying opening and closing times during lifetime of installation.
- Input data from temperature and vibration sensors on fan motors shall be recorded and presented graphically with a trend displaying values during lifetime of installation.
- There shall be alarms given to the HMI when vibration and temperature limits are exceeded. Limits shall be decided during commissioning.

Control functions shall be simplified as far as possible, considering the reliability of the ventilation systems and components.

Control equipment including I/O and interfaces shall be designed such that one single fault does not cause a shutdown from overheating or a full loss of control/monitor functions from ESI SCADA.

All dampers required to close in fire scenarios shall be automatically operated from fire system.

All dampers shall have limit-switches (proximity type) for signals on open and closed position for remote operation and testing. It shall be possible to test individual dampers remotely in an unmanned setting from onshore CCR without risk to losing HVAC services to room. Fire dampers shall be tested automatically every three months as a minimum. Contractor shall create an automated sequence of opening and closing fire dampers. Opening and closing times of dampers shall be recorded and presented graphically with a trend displaying opening and closing times during lifetime of installation.

Emergency/stand-by fans shall have periodic maintenance runs to verify technical functionality. Intervals and running time shall be agreed with Company.

Manned/unmanned mode shall be implemented in the design of HVAC and shall be both manually controllable from multi-purpose area at the OSS and remotely via ESI SCADA. If the OSS design has manned/unmanned modes for other systems, e.g., lighting, it shall be combined on the same physical switch located at the multi-purpose area but separate in ESI SCADA.

4.3.3 Air quality and temperature

The HVAC ambient design temperatures and RH are:

- Winter minimum -10°C and 100% RH
- Summer maximum 26°C and 80% RH

The HVAC design shall also account for the maximum 35°C and minimum -19°C ambient conditions at 100 year return period and 100 m above sea level without risk of damage to equipment and systems.

Temperature in mechanically ventilated rooms shall be dictated by the specific equipment requirements in that room and shall ensure operation in all ambient conditions.

The multi-purpose area (ref 3.1.3) air temperatures shall be controllable between 19-26°C, during manned mode at all ambient conditions. It shall be possible for local adjustment of temperature as well as via ESI SCADA.

Air temperature in all other mechanically ventilated rooms shall be controllable between 5-35°C during maintenance campaigns.

The HVAC system shall ensure that all mechanically ventilated rooms in all ambient conditions have relative humidity levels within the required range defined by specific equipment requirements.Minimum fresh air exchange for a given room shall be, at least, 7 litres per second per person or in accordance with relevant Polish authority requirements (the stricter requirement prevails).

Multi-purpose area shall accommodate POB, control rooms six (6) man working team and all other rooms/areas four (4) man working team for sizing the minimum air exchange.

For all mechanical ventilated areas filters shall have minimum dust filtration according to class ePM1 75% with efficient water separation.

More details regarding equipment environment tolerances are found in chapter 5.

4.3.4 HVAC design

The main HVAC system covers all mechanically ventilated rooms except for the multi-purpose areas. The main HVAC system design is based on a recirculation unit with heating and cooling coil and with partial fresh air and bleed-off to ambient. Local heating is preferably done with wall-mounted heaters.

The auxiliary HVAC system covers the multi-purpose areas (ref. 3.1.3) and other rooms on the lowest topside deck, and consists of a fresh air mechanical supply system and a mechanical extract system. Local heating is preferably done with wall-mounted heaters.

The battery rooms shall be provided with redundant local extract fans separate from main extract system.

Rooms shall be cooled by the ventilation system The air shall be cooled in the air handling units by a cooling circuit, with outdoor air-cooled chillers and indoor located chilled water recirculation pumps. Heating of rooms shall primarily be done by the ventilation system. However, wall mounted heaters may be installed in rooms that require additional heating.

If strictly necessary, FCUs can be considered installed.

The sparing / configuration of the HVAC system shall be:

- Main Air Handling Units (AHUs) in a 2 x 100% arrangement
- Air Extract Units (AEUs) in a 2 x 100% arrangement
- Local FCUs in a 2x100% arrangement where FCUs are required
- Auxiliary Air Handling Units (AHUs) in a 2x100% arrangement for multi-purpose area on cellar deck
- Chiller units in a 2 x 100% arrangement
- Chilled water recirculation pumps in a 2 x 100 % arrangement

Battery room extract fans in a 2 x 100 % arrangement (NRTL certified for H2 gas group)Fire dampers in a 2x100% arrangement

AHUs

Air Handling Units (AHU's) shall have fresh air intake. The supply of each AHU shall be connected to a central supply duct network for treated air distribution to all rooms on the platform. All main AHUs shall be identical in design. Each AHU shall have motorized damper downstream and upstream of fan to facilitate maintenance and prevent spreading of smoke in case of fire in fan motor. Cooling coil shall be placed downstream of fan,The outlet temperature of the AHU shall be approx. 15 °C (subject to final design values). Air handling units shall not be places outdoors.

Auxiliary AEU

Air Extract Unit (AEU) shall have exhaust air discharge to the environment. The AEU shall be connected to a central extract ductwork from multi-purpose area. Each AEU shall have motorized damper downstream and upstream of fan to facilitate maintenance and prevent spreading of smoke in case of fire in fan motor. Air extract units shall not be placed outdoors.

Auxiliary AHU

Auxiliary Air Handling Unit shall have fresh air intake. The supply of the auxiliary AHU shall be connected to a supply ductwork for treated air distribution to multi-purpose area. The auxiliary AHU shall have motorized damper downstream and upstream of fan to facilitate maintenance and prevent spreading of smoke in case of

fire in fan motor. Cooling coil shall be placed downstream of fan, Auxiliary air handling units shall not be placed outdoors.

Cooling system

The cooling system consists of 2x100% chillers with traditional refrigerant expander/compressor circuit installed indoors, 3x50% or 2x100% dry coolers located on roof deck, and distribution system between chillers and consumers. The design shall be optimized to avoid piping and equipment exposed to outdoor saliferous atmosphere, to minimize risk of corrosion.

The chilled water circuit shall be designed for a constant flowrate, and the chilled water temperatures are approx. 6 °C (supply) and 12 °C (return; at maximum load) (subject to final design values).

Dry coolers shall be prepared for and sized to be lifted on/off the OSS as a whole with platform crane in case of replacement. Final location of the dry coolers shall either be in reach of platform crane or have a safe and efficient handling method to be moved into the reach of platform crane.

The condenser water and the chilled water in the cooling system shall consist of 40% MEG. Contractor shall evaluate if heat tracing of outdoor pipes is necessary.

Contractor shall evaluate whether VSD drive is beneficial for the pumps in the chilled water system, or if a three-way valve and fixed-speed motor is a better solution.

FCUs

FCUs shall be avoided unless strictly necessary. If FCU is required, the type, design and location shall be approved by Company.

If FCUs are necessary, chilled water piping to FCUs shall be routed outside of electrical room(s), instrument room(s) and control room(s) to extent possible. Leakage from the FCUs and piping shall be such that it shall not introduce risk toward other equipment, pipe-in-pipe, enclosure and other similar mitigation shall be used. The chilled water piping shall be executed as a single circuit as the probability of failure is low.

Ducts and piping

The ductwork at the platform shall be executed as a single circuit as the probability of failure is low.

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Design of ductwork shall allow for recirculation with partly fresh air and bleed-off to ambient.

Duct pressure drop simulation tool shall be used during duct design to optimize duct sizes, velocities, pressure drop and noise.

Location of of equipment shall be designed for easy access during balancing, maintenance and inspection. This includes necessary hatches for inspection and cleaning of ductwork.

Cooling medium system – chilled water

Chilled water piping from chillers to AHUs shall be routed outside of rooms with moisture sensitive equipment to the extent possible. Leakage from piping shall be such that it shall not introduce risk toward other equipment, pipe-in-pipe, enclosure and other similar mitigation shall be used to direct leakage away from equipment/area.

Leakage and spills related to the cooling medium system shall be handled and controlled by the drain system. The chilled water piping shall be executed as a single circuit as the probability of failure is low. There shall be means for emptying the system into a temporary tank/bottles during maintenance, without spilling the cooling medium to the drain system.

A sample point shall be included to allow quality monitoring of the cooling system with respect to degradation and/or contamination. Facilities shall be available for drainage of cooling media by gravity for collection for disposal or re-use.

Design flow capacity shall have a 20% margin.

If the cooling medium system is made of carbon steel, the following applies: • A slip stream filter shall be installed.

- The slip stream rate shall be minimum 10% of the total flow rate.
- Provision for injection of corrosion inhibitor/pH regulator upstream of circulation pumps shall be included.

The design shall include a solution for and easy draining and refilling of cooling medium.

The circulation loop shall be arranged to reduce number of high and low points:

- All high points shall be equipped with accessible vent with valve to allow for system priming
- All low points shall be equipped with accessible drain with valve to allow for system drainage

Temperature control valves shall be located downstream heat exchangers. To ensure minimum flow or a more constant flow rate, a line from supply to return side of the circuit is normally provided. If provided, there shall only be one such by-pass line. Valves in by-pass lines shall not be used to control the flow through individual heat exchangers. Expansion tanks shall be included in closed loop cooling system.

The expansion tanks shall have capacity to control volume expansion from temperature variation (between minimum ambient and maximum operating) within 25% and 75% of the total tank volume. The expansion tank shall be located at the highest point in the circulation loop. The system shall be designed for differential pressure monitoring across the strainer and the heat exchanger.

4.4 Diesel Generator

The diesel generator shall be designed for continuous powering and sufficient capacity to supply all loads guaranteeing correct operation and safety of operation of the substation for a minimum of 7 days in the event of loss of power via the earthing and auxiliary transformers (EAT), ref chapter 4.5.

A standard, off-the-shelf, diesel generator set shall be selected, with well-proven track record in similar use and environments. Two smaller diesel sets are accepted if deemed optimal.

The diesel generator shall:

- Be self-contained and autonomous with all required utilities, monitoring and protection.
- Be delivered with enclosure (containerized solution).
- Be air-cooled and positioned outdoors.
- Be equipped with means for safe lifting and transport in an offshore environment.

- Be sized to be handled by the offshore crane as one unit or have a modular design to enable safe and efficient splitting into smaller units for individual handling on/off the installation in case of repair or major maintenance.
- Have standalone active FiFi and FiDe systems. The FiDe system shall interface with the platform systems to activate GA and alarms to ESI SCADA.
- Have manual emergency stop facilities outside enclosure, and at control panel if remote mounted
- Be connected to both A and B main LV switchboards through the tie in, ref 6.4 and within 45 seconds automatically start upon detection of zero voltage on both A and B main LV board auxiliary transformer incomers and connect to the auxiliary system.
- Be designed to enable start at -17 °C ambient temperature in cold condition.[1]
- Be equipped with temperature-controlled engine heater and other heating arrangements shall be provided to ensure start in minimum ambient temperatures.
- Cover all required loads during island mode (loss of grid power) with minimum 15% allowance for load increase during lifetime of plant. Duration of island mode is limited by the amount of diesel stored, ref 4.5.
- Not require load shedding systems. The diesel generator (DG) shall be able to connect to the main LV switchboard and re-start all connected loads in case of sudden loss of grid within voltage and frequency limitations. Staggered start-up of auxiliary systems shall be avoided
- Be capable of starting without external power supply and after long periods without operation. The start-up and operation of the DG shall be independent and autonomous.
- Be designed with manually selected black-start mode where all external block signals can be overridden.
- Be equipped with dual battery starting system which:
    - Have sufficient energy stored for three consecutive starts each.
    - Have temperature compensated charging at all temperatures
    - Include facility to connect to an external battery pack

When returning to normal after a transmission outage, there shall be a manually initiated automatic sequence for synchronising and connect the OSS LV system to the HV system, offloading DG, opening generator breaker and stopping the engine after cooldown. This sequence shall be possible to initiate both locally and via ESI SCADA. It shall also be possible to perform each of the steps in this sequence manually one-by-one locally and via ESI SCADA.

The diesel generator shall have alarm and control functionality through ESI SCADA. The following control actions shall be available through ESI SCADA and locally at the Generator Control Panel (GCP):

- Start/Stop
- Run on-load test
- Block/inhibit

The following parameters shall be shown on GCP and ESI SCADA

- Status
- Measured values including minimum: V, I, P, Q, pf, loading in percentage, fuel level, fuel consumption, oil level, engine temperature, battery starter capacity.
- Alarms and error messages
- Status on fire detection and fire fighting

[1] Guidance: the engine is equipped with temperature controlled heater powered by normal power, hence the engine is warm and ready to be started regardless of ambient temperature. The cold start refer to a cold machine where it has not been pre heated, typically black start.

- Accumulated running hours, both a resettable and a not resettable parameter

Advanced functionality of the diesel generator system such as configuration and troubleshooting/diagnostics shall be accessible through a separate portal via remote access. For clarity, a separate fixed workstation is not required.

Diesel engine shall follow the Emission standards as specified by IMO Tier III with EIAPP certification.

4.5 Diesel system

A diesel system shall be installed to facilitate diesel storage and bunkering of diesel to the OSS. Emission standards shall be clearly specified.

See chapter 4.4 for specific requirements to DG, and chapter 4.6 for hose and coupling requirements.

Single diesel storage tank embedded in DG enclosure/skid is preferred over separated day-tank and storage tank, example shown in Figure 2. A single diesel storage tank embedded in platform deck may be used, but the DG enclosure/skid should position directly above to maintain a simplistic design. Cleaning and maintenance inside diesel storage tank(s) shall be possible without personnel being subject to a confined space.

All manual valves shall have a permanent access or be installed such that the valve's wheel or lever can be operated from the deck level.

Figure 2. Example of diesel generator with "diesel storage tank embedded in DG enclosure/skid"

Source: www.cat.com

The total diesel storage shall have capacity of providing 7 days at full engine load(asset protection and availability during island mode).

Additional diesel storage capacity of 2 hour per month for remote testing of DG shall also be included.

If a separate DG day tank is installed, it shall have minimum 24 hours capacity, where 18 hours are available for use and the remaining 6 hours are reserved for black start with manual override.

If a separate DG day tank is not installed, it should be included a 6 hours reserve volume of diesel for black start in the total diesel storage.

The location of diesel system, including refilling system and piping, shall minimize fire risk.

The diesel system shall be winterized to avoid change of diesel between summer and winter. Alternatively, first fill of diesel suitable for the temperature can be used.

Special considerations shall be taken with regards to spill of diesel on hot surfaces and measures to avoid this, see PS 6 in /17/.

The transfer pump(s) shall transfer diesel from diesel storage tank(s) to diesel generator day tank, if installed. The transfer pump(s) shall be powered from the generator set/Main switch board. Day-tank shall be delivered with diesel prior to commissioning. There shall be controls protecting against hazards introduced with dry-running of the pump(s). Fuel line(s) between storage tanks and DG shall include quick-acting closing valves controllable via ESI SCADA and automatic from platform/DG FiDe system. It shall be possible to reset/open valve(s) remotely via ESI SCADA.

All available parameters of the diesel system, including minimum fill-levels, flows, temperatures, valve status, shall be available in ESI SCADA.

The design pressure of the entire diesel system shall be 16 barg. Test pressure of the system shall be 30 barg. Tanks in the diesel system can have atmospheric pressure as design pressure if the tanks are equipped with a separate vent to a safe location and a separate overflow without restrictions (e.g. valves) to a safe location. The vent shall be sized according to maximum inflow and outflow of the tank. The overflow shall be sized according to the maximum inflow. If these requirements are not fulfilled, the tanks must have 16 barg design pressure.

Long term storage of diesel shall be evaluated in the design and deteriorations of diesel shall be mitigated. The mitigating design shall be optimized to the lowest operational costs. Minimum design is:

- permanent diesel oil treatment system, see more details below
- tank(s) should permit mechanical cleaning of tank(s)
- location of diesel storage tank(s) shall be outdoors and should minimize sun radiation to be kept cool in order to minimize water absorption.
- Storage tank(s) shall have facilities to drain accumulated water.
- All diesel storage/day tanks should have the facility to add biocide to prevent diesel bug
- Diesel system piping shall be designed to minimize low points and dead legs due to risk of biological growth.
- The supply line from the loading station to the storage tank shall be fully welded without any flangepairs outside bounded areas or driptrays. There shall be no local low points on the supply pipe
- Water settling out of the diesel shall not freeze anywhere in the system.

A permanent diesel oil treatment system for water and particle removal shall be provided. Requirements for particle and water removal shall be based on specific consumer requirements. Filter coalescers rather than centrifuges should be used for water removal. Filter coalescers shall have an N+1 configuration.

Storage tanks shall be equipped with level measurement or switch giving alarm on low and high level. Shut down functions on low-low level shall be evaluated. To prevent overfilling the tanks, feed shall be stopped by an automatic shut-off valve. There shall also be a manual valve on the diesel filling line to main tank, to enable an operator to manually shut off the flow during bunkering of diesel from a vessel.

Each storage compartment/tank shall include a low point for gathering of water and tank bottom shall be sloped towards the low point. Portable or permanent suction pump can be used to drain water from the low point. Any internal structure(s) in the tank(s) shall not obstruct the efficient drainage of the tank(s).

Sampling points shall be installed at (where applicable):

- loading line(s)
- raw diesel storage tank outlet(s)
- outlet of water removal equipment at the outlet of the treated diesel tank, if provided
- downstream diesel filter in distribution system
- diesel day tanks

Primary mean for bunkering of diesel or emptying of diesel is via a hose to a vessel. The OSS shall be equipped with a geared hose reel station suitable located to enable bunkering to/from CTV and SOV. During normal storage, the hose is to be stored on the reel and lowered to the vessel. Once bunkering is finished, the hose is to be retrieved to the hose reel.

- The supply pipe shall be emptied after the diesel storage tank is filled, and the remaining diesel in the supply pipe drained back to the SOV / CTV. The design of the supply line shall accommodate this.
- The supply pipe shall have a drain point near the loading station for emptying any water in the supply pipe before refilling of diesel.

The hose reel system shall be electric driven with the possibility for manual operation. The speed of the hose reel system shall be adequate to quickly lower or retract the hose safely (minimum to accommodate Hs 3 m). The reel arrangement shall be equipped with a gearing arrangement preventing un-controlled reeling out of hose. The reel arrangement shall have an enclosure to shield the hose from environment when reeled in. The hose and inlet pipes to diesel tank shall tolerate potential liquid hammers.

The vessel will be equipped with required pump facilities. Minimum lifting height for the pump onboard the vessel shall be verified.

The diesel piping shall have continuous slope to ensure no trapped diesel after use.

The diesel system shall also accommodate for bunkering of diesel or emptying of diesel via tote tanks.

It shall be possible for operators to monitor the level in diesel tanks during filling/emptying of diesel and manually close the inlets/outlets.

It shall be possible for operators to communicate with SOV/CTV during filling/emptying of diesel.

4.6 Hoses and couplings

All hoses and connections (hose assemblies) are to comply with TR1803. This includes diesel bunkering and associated hose reel station, and facilities to empty the oil drain tanks in case of oil leakage from transformers.

Guidance note: TR1803 Table 14 include specification for hoses and couplings for diesel on the topside, while table 25 include specification for the bunkering diesel hose.

For the entire diesel systems, including hose reel and loading lines, the design pressure shall be 16 barg. Test pressure of the system shall be 30 barg

The hose reel station hose shall be equipped with quick release auto close connection on the CTV end. Hoses shall be fitted with a breakaway coupling to avoid a spill to sea when bunkering.

For diesel systems the maximum working pressure shall be minimum 10 barg for all hoses and connections.

Test pressure of the hose and couplings shall be executed by applying 1,5 X max. WP to the hose assemblies with minimum 10 minutes holding time, or according to relevant standard if higher than 1,5 x WP.

Guidance note: The pump at CTV/SOV is rated at maximum 9 bars, hence providing a safe system.

4.7 Fire protection system

The installation may be equipped with the following active fire protection systems:

- Water mist system
- Inert gas suppression system
- Fixed expanding foam system

In addition to portable fire extinguishers.

Due to lack of water supply all water based systems shall be self-contained systems.

Reference is made to safety strategy /17/ for specification and further details regarding fire protection systems.

4.8 Condition Based Monitoring (CBM)

For the condition monitoring shall be implemented on systems and equipment with the following goals:

- Reduce maintenance man-hours or frequency for visits
- Enable condition-based maintenance
- Monitoring of asset condition by data collection and analysis to review asset health and future maintenance need and predicting failures
- Monitoring of the asset condition to support potential life extensions of plant

CBM to be according to Automation Technical and Functional requirements C256-EQ-J-SP-00002 /21/, and Appendix E documents.

Contractor shall propose condition monitoring systems to Company for review and acceptance.

All condition monitoring systems shall be fully operational prior to equipment energization such that “day 1” and onwards data is captured and stored.

In general, the implementation method of CBM is to utilize existing sensors and data for transfer to, and analysis in, Company IMS.

4.9 Bird protection and guano

All openings (HVAC ducts, vents and similar) shall have mesh to ensure bird ingress is prevented. Where reasonably practicable, structures shall be protected from bird nesting and resting to reduce chance of excessive guano build-up. Equipment located outdoors shall be designed to minimize risk of bird nesting by:

- Reduce light emissions
- Reduce available area
- Use of spikes and/or bird scares (consider an automated bird scaring system)
- Design of handrails to prevent birds form sitting on them

- Reduce equipment located outdoor to extent reasonably practicable

Active bird deterrent systems may be considered by Contractor as a system to prevent excessive guano on the OSS.

5 General requirements for equipment

5.1 General

Equipment to be installed on the OSS shall be designed to be fully operational in the ambient conditions where it shall be installed.

- For equipment installed outdoors the ambient extremes found in **Error! Reference source not found.** shall be used.
- Equipment installed in HVAC controlled environments shall adhere to the relevant room temperatures given in 4.3.3.
- During UPS mode, equipment shall operate in +40 °C without loss of availability, reduction in lifetime or violation of warranty.
- Equipment located in naturally ventilated areas shall be designed for +40 °C ambient temperature.

All equipment and systems to be installed on the OSS shall have documented mean time to failure/mean time to repair and lifetime expectancy.

Equipment with anticipated shorter lifetime expectancy than design life of the installation shall be specified in relevant documentation. Method of replacing, duration of the work and replacement cost of such equipment shall be identified and estimated.

Enclosure material and material selections shall be according to /7/.

All equipment and applicable components shall be designed to facilitate material handling as established in chapter 10.

IP rating of enclosures and equipment shall adhere to site conditions and vendor instruction, but not less than (or equivalent Polish designation):

- IP56 for equipment installed outdoors or in natural ventilated areas
- IP21 for equipment installed indoors with controlled atmosphere (forced ventilation)
- IP20 inside equipment compartments (door open)
- IP00 for air insulated electrical equipment is only allowed if area/room is blocked and interlocked whilst energized

Hinged doors on equipment located outdoors or if door is equipped with components shall have a device for securing the door in open position. Doors shall not obstruct escape ways. Hinged doors shall at least open 95 degrees.

All metallic parts shall be bonded to structure.

Switchgears, distribution boards, UPS, P&C panels and similar shall be designed to allow for thermo graphic inspection of power connections and terminations whilst live.

Breakers and MCBs for the external consumers (consumers outside of the enclosure the MCB is located) shall be prepared for use of padlocks.

All cabinets and enclosures containing wiring shall be provided with relevant circuit wiring diagram for internal wiring and an MCB/fuse schedule for external consumers. The documentation shall be kept updated during all phases of the project and reflect as-built status.

All electrical, instrument and telecom (EIT) equipment, field equipment and internal cabinet equipment, shall have low halogen content and shall be flame retardant as a minimum.

Internal wiring in cabinets shall have flame retardant and halogen free insulating materials.

The control wiring shall be segregated from the power wiring, internal wiring shall be separated from external wiring. Supplier standard for internal wiring is accepted for the type approved parts when required to maintain the type approval.

All panels and cubicles containing electrical components or external cables shall have PE bar easily accessible. A separate IE bar shall be provided where applicable.

Spare cores from multicore cables and power cables shall be marked as “SPARE” with associated cable TAG number. The spare core shall be terminated and earthed in each end. As-built documentation shall include all spare cores.

For marking and labelling of equipment see chapter 5.5.

Field equipment located in areas which do not allow for maintenance accessibility as required, should be installed such that the equipment can be rotated, raised or lowered into areas where maintenance can take place without the need for scaffolding.

Field equipment located above occupational areas, walkways and accessways shall be provided with an extra safeguarding against falling.

Field equipment should not be mounted on fire-proof steel structures. If such installation cannot be avoided, field equipment shall be mounted with machine screws, nuts and lock washers on a plate welded to an outrigger. Outrigger shall be welded to steel structure before the fireproofing is installed.

Drain plug in equipment shall be used in outdoor and naturally ventilated areas.

The operation of push buttons and control units shall be consistent across the facility, e.g. push vs pull on E-stops.

Power distribution switchboard assemblies shall have free space according to manufacturer’s recommendation to allow hot gas expansion from arc fault.

Switchboard shall be installed so that extension to at least one end is possible. Switchboard foundation and equipment room floor shall be prepared for such an extension. This is not applicable to minor switchboards serving a dedicated system.

LV cubicles, distribution boards, sub-distribution boards and switchboards shall have at least 10 % spare space for additional equipment/MCBs (circuits) after installation.

In front of switchgear the floor shall be insulating or insulating mats shall be provided. This applies also to the rear of switchgear if access is required.

5.2 Padlocking

Padlocking facilities shall be provided to control access to equipment and operation of equipment both on HV, LV and utility systems, with purpose to ensure safety of people and workplace.

- All panels and cubicles shall have facilities for padlocking.
- All equipment shall have facilities for padlocking of its compartment(s).
- All pushbuttons and switches controlling HV systems or interlock systems shall have padlock facilities

5.3 Final circuits in switchboards and distribution boards

5.3.1 Consumers fed from UPS systems

Emergency services fed from UPS and other UPS powered services shall have two independent supplies, one duty and one stand-by.

- This is not required for individual emergency light fixtures, sockets or other field equipment supplied directly from UPS as the design shall ensure every other field equipment is fed from system A and system B respective along a walkway or in a room.
- This is not required for long duration services (96 hrs) such as structural marking, AIS, fog horns, aviation lights and navigation lights.

Where the consumer requires an AC-voltage and the external power supplies are AC-voltage, an automatic changeover shall be implemented between two separate external supplies. Consumer shall withstand loss of power supply during change over period.

Where the consumer requires a DC-voltage and the external power supplies are AC-voltage, two independent rectifiers (2 x 100 %) with separate external supplies shall supply the circuits in parallel, merged by appropriate diodes.

Where the consumer requires a DC-voltage and the external power supplies are DC-voltage, two separate external supplies shall supply the circuits in parallel, merged together with appropriate diodes.

Necessary measures shall be implemented to ensure that voltage from one supply do not feed back towards the source of the other supply.

The supply locally at consumer shall be protected by use of local MCBs including earth fault protection to ensure high reliability and avoid sequential trip of both external supplies due to same fault. The distribution locally at consumer shall be segregated by use of MCBs so a fault in a less important component shall not cause loss of control voltage to other critical parts.

Each external supply shall be monitored with an alarm for loss of availability.
In case of rectifiers, each rectifier shall be equipped with fault alarm (including supply availability).

Low voltage DC supply requirement at equipment, like 24VDC or 48VDC, shall be provided with redundant DC/DC stepdown or AC/DC inverters locally in/at equipment.

5.3.2 Consumers fed from auxiliary power systems

Where “A and B” consumers exists, the A consumer shall be connected to the A auxiliary power system and B consumer to the B auxiliary power system. Where “A, B and C” consumers exists, A and C shall be connected to the A auxiliary power system, and consumer B to the B auxiliary power system.

Non-redundant operationally important consumers shall have connection to both A and B system with local autonomous changeover.

The local autonomous change over shall:

- have the capability to change between the incoming supplies without impacting the supplied consumer and/or service it is providing
- have possibility change between the incoming supplies and inhibit/block change over function locally and via ESI SCADA
- have facility to locally set the change-over in ‘local’ mode blocking commands from ESI SCADA

5.4 Cabling

Guidance note: For equipment internal wiring see above 5.1. This sub-chapter covers cabling between equipment.

Cable requirements

Cable requirement shall be according to TR3023. The primary wiring method outside of enclosures shall be cable installed on ladder/tray/channel. All electrical, instrument and telecom (EIT) cables shall be halogen free and flame retardant. EIT cables shall be marine shipboard type according to IEC standards and Polish regulations.

EIT cables shall be protected by copper wire braid/screen, with the exception of fibre, LAN and coax cables. Control cables with analogue signals shall have individual and overall screen, control cables with digital signals shall have overall screen.Careful evaluation shall be done for cables in exposed areas, such as transport routes, material handling areas etc.

Data and LAN cabling shall be CAT6A STP type with solid copper wire type.

Coaxial cables for outdoor use shall have a corrugated screen. Braided screens shall be used for indoor cables only.

All instrument and telecom cables shall be sufficiently shielded against EMC, having collective screens as a minimum requirement. Electrical cables are only required to have EMC shielding where this is required following relevant EMC and EMF studies.

Multi-core cables shall have collective shields/screens and this shall be used by default. Individual screens shall only be used where required. If twisted pairs are used the installation and handling of cables shall adhere to the cable supplier recommendation to avoid damage.

Where fire resistant cabling is required, the cable shall be according to IEC 60331.

Cables which are required to function during a fire shall be fire resistant (according to IEC 60331). All other cables used shall minimum be flame retardant (according to IEC 60332-3).

Ground conductor requirements shall follow IEC 60364. For services above 30 VAC or 50 VDC there shall be a dedicated ground conductor integral to the cable, sized without considering the return path through armor or externally. Contractor may propose alternative methods subject to Company approval and shall demonstrate the proposal is IEC compliant.

Cable installation

For Cable ladders, tray and channel for non-climate controlled spaces reference is given to the Material selection philosophy document /7/..

For outdoor located equipment, cables shall only enter from underneath via suitably rated cable glands or cable entry systems. If side entry must be used, for e.g. light fixtures or other equipment where bottom entry is not possible, a drip loop shall be introduced immediately before the gland entry. Outdoor cable gland material shall be brass with nickel plated threads, fully nickel plated brass, marine grade aluminum, or AISI 316L stainless steel. Galvanic corrosion shall be mitigated as per /7/.

The installation of all cable transits, glands and entry systems shall maintain the IP rating of the enclosure into which it is connected.

The minimum permissible bending radius specified by supplier shall be adhered to. If not otherwise specified, the minimum bending radius should not be less than the following:

- High voltage cable 9 × cable outer diameter
- Low voltage cable 6 × cable outer diameter
- Instrument cable 6 × cable outer diameter
- Fibre optical cable 10 × cable outer diameter

Sufficient spare cable length shall be provided for equipment that may need future adjustment or where equipment has to be dismounted for maintenance and calibration without disconnecting the cable. Spare cable length shall be adequately supported. Typical equipment is loudspeakers, fire detection units, CCTV cameras, warning lights, floodlights.

For earthing of cables (screen/braided armour) see below “cable termination” and chapter 6.10

Where cables are penetrating fire rated walls the cable transit shall be fire rated to same level as wall.

Cables not in use shall be removed.

Splicing of cables should be avoided. As-built documentation shall include any location of cable splice.

Cable ladders and trays, exposed to mechanical damage by material handling equipment or situated in walkways/material handling routes/lifting zones or similar, shall be protected with removable covers.

For cables not UV resistant, exposed outdoor cables shall be covered.

For strapping of fibre-optical and coaxial cables, supplier guidelines shall be adhered to.

Cable ladders 300 mm and above shall each at least have 20 % spare space after installation.

Cable routing shall be segregated by minimum 300 mm distance on same or between different cable ladders/trays following the below cable systems:

- System 1: HV systems >1 kV
- System 2: LV systems including control voltage supply
- System 3: Instrumentation and telecommunication systems

“System A” and “System B” cable routing to A/B redundant units or dual supply to a non-redundant unit shall be routed separately, this applies to all cabling to that equipment (system 1,2,3)

A computer-based cable routing design system reflecting the layout of the main cable support system (cable ladders with width 300 mm and larger) shall be used. This design system shall give ladder segment references, transit numbers etc. and necessary describing information related to the individual cable including its route.

Cable termination

Through type glands shall be used if not otherwise specified by vendor or to achieve correct EMC earthing. Any armour shall be terminated at the gland. Screens shall be carried through the gland, fitted with yellow/green heat shrink sleeve and terminated to earth bar without reduction in cross section area. Screen shall be terminated in sequence with associated cable cores in termination block(s).

Ferrules used shall be tinned copper crimped type. The use of compression lugs and ferrules shall be according to the terminal used. Compression lugs shall be used when connection is bolted.

Supplier torque recommendations shall be followed for cable termination in all equipment.

Only one core per termination terminal is allowed. Two conductors may in certain cases be used in one approved type ferrule connected to one terminal

The installation and termination of cables, armour and shielding shall be in accordance with chapter 7 in/24/ The PE supply and screen shall be continuous from central to field end: any junction boxes used shall ensure continuation.

5.5 Marking and labelling

General

Signs and markings shall adhere to /17//17/.

All equipment shall be provided with traffolyte TAG labels, having black letters on a white background. Equipment associated with emergency services shall have white letters on a red background.

For smaller replaceable equipment like instruments, GA loudspeakers, motors, lighting fixtures, flood lights, push buttons, junction boxes and socket outlets the label shall not be fixed directly onto the equipment, but adjacent on the location where the equipment is mounted.

Labels shall be environmental resistant, i.e. resistant to sunlight.

For smaller items located indoors marking and labelling can be done with use of Dymo labellers or similar.

Service description on labels shall be in Polish and English. Labels on red background shall have the service description both Polish and English.

Piping, valves and tubing as a replacement of piping shall be marked according to TR2321 and appendix A.

Note; TR2321 appendix A and TR3023 The product service marking text in Norwegian shall be replaced with Polish text. Translated Polish text must be in agreement with Join Venturet.

Main equipment

For main equipment like central telecommunication and automation equipment, main switchgears, distribution boards, frequency converters, transformers, control panels, etc., the label shall be fixed on the most visible place directly on the equipment. The labels shall be attached to the equipment by stainless steel fixing screws. The labels shall clearly identify the tag number and the service description of the equipment.

The main equipment shall also have a separate label at the front giving information from which switchboard and circuit the equipment is supplied. This is not relevant where it is obvious where the equipment is supplied from.

Arc flash hazard labels shall be provided on switchboards and distribution boards recommending the PPE levels and/or arc incident energy levels. See also chapter 6.4.

Lighting fixtures

The label shall be installed visible from floors, walkways etc. The tag code used shall be selected in a logical manner enabling the user to identify which circuit and distribution board the fixture is fed from, and this fulfils the requirement from where the lighting fixture is supplied.

Push buttons and control units

Push buttons/control units shall be labelled with service description and tag number.

Junction boxes and socket outlets

All junction boxes and socket outlets shall be labelled with voltage level and switchgear cubicle or distribution board feeder circuit.

Socket outlets with feeder circuit from UPS systems shall have label with red background and white letters.

Data and telecommunication outlet

Data/telecommunication outlet tag labels shall be fixed to the outlets, and label size must be adapted to the available space.

Telephones

Telephones shall be marked with emergency call number and other important telephone numbers.

Cables

Stainless steel labels, or plastic labels with documented sufficient lifetime, shall be used for all underground and outdoor above ground cables included cables inside machine houses or similar. Plastic labels can be used for indoor cables in mechanically ventilated areas. Cable cores shall be marked with terminal number.

The earth core/braiding shall be marked with the cable number. This is not required in small junction boxes with few cables, like junction boxes for heat tracing, lighting, etc.

Each cable shall have a label at each cable end and on both sides of any cable penetration. Where transits are covered by flame resistant materials, the cable labels shall be put in sufficient distance from the transit to avoid the labels to be covered by the protecting material.

Control cable cores shall in both ends be fitted with plastic ferrules. Each core shall be numbered with the terminal number shown on the drawing. This also applies for small power cables.

The colour code on cable cores shall be according to TR3023 and adhere to Polish rules and regulations.

Additional telecommunication requirements shall apply:

Telecommunication cable pairs shall generally be identified by pair numbers

For telecommunication cables type S9 (0.5 mm diameter) connected to knife type blocks (insulation displacement connection), pair marking will not be required, and the colour coding of the cable pairs will be sufficient

Marking of cross connection conductors is not required

Patch cables inside cabinets should be labelled with to-port, service and from-port in both ends, thereby informing of which port the patch shall be connected.

Where installation is undertaken on territory in the control of others, 'The Contractor' agrees the correct labelling to be put in place with the relevant authority.

Earth bars

PE bars shall be marked yellow/green.

6 Electrical systems

Reference to /13/

6.1 Offshore HV electrical system

The High Voltage electrical system on the offshore platform consist of 10 subsea IACs connected to 66 kV pluggable joints on cable deck, followed by topside 66 kV flexible cables connected to 66 kV GIS switchgears.

The 66 kV GIS switchgears are connected to the 220 kV GIS switchgears via two 220/66 kV step-up transformers. The connection between the 66 kV GIS switchgear and the 220/66 kV transformers shall be Duresca busbar system. The connection between the 220/66 kV transformers and the 220 kV GIS switchgear shall be delivered by export cable contractor. From the 220 kV GIS switchgears two submarine export cables export power to the ONS.

The 66 kV and 220 kV GIS switchgears for A&B system shall be segregated into separated GIS rooms by a fire wall. While the 220 kV GIS switchgear are fully separate, the 66 kV GIS switchgear are connected by a normally open bus-tie circuit breaker.

The 220 kV system is directly earthed through the main transformers high voltage winding, while 66 kV system is earthed though the combined 66 kV earthing and auxiliary transformers.

The main transformers are two winding D/Y transformers. Final transformer designs will be decided by the ESON contractor.

The arrangement of HV equipment shall allow for minimum crossing of HV cables/bus ducts and bottom entry through deck.

It shall be possible to disconnect and earth all equipment for inspection, maintenance, and repair.

6.2 1Topside 66 kV cable

To minimize offshore installation hours and risk of damaging IAC cables, 66 kV topside cables between IAC and GIS switchgear shall be used, pre-installed, terminated to GIS switchgear and tested at OSS yard. It shall be used pluggable joint between IAC cables and topside cables. The pluggable joint terminations shall be dry type.

The location of the pluggable joint shall be on the topside and vertically above each IAC hang-offs on the jacket. It shall facilitate for vertical termination of IAC into the pluggable joint. The length of IAC to the pluggable joint shall allow for a re-termination of the IAC to the pluggable joint by moving the pluggable joint closer to hang-off. The topside 66 kV cable shall have snaked or bundling to allow for such re-termination of the IAC in addition for one re-termination of the topside 66 kV cable into the pluggable joint. Snaking or bundling shall also allow for re-termination at the 66 kV GIS switchgear.

It shall be ensured that cable ways to GIS allows for sufficient bending radius according to cable data sheet, including a minimum straight run for termination kit.

The topside 66 kV cable shall be designed according to appendix E. Design shall be coordinated together with relevant interface contractors.

6.3 Offshore export 220 kV cable

The base case for the two export cables is to have submarine export cables directly terminated in the 220 kV GIS. Alternative as option is to use pre-installed topside cables spliced with submarine cables. The cable routings shall allow for the bending radius given by the export cable contractor and enough overlength for one re-termination.

6.4 Offshore auxiliary electrical system

The auxiliary electrical system shall operate at a nominal voltage of 420 V and 50 Hz and consist of two redundant and independent systems denoted “A” and “B”.

Auxiliary power system A & B shall be segregated into separate (transformer, battery, LV cabinet, etc.) rooms by a fire wall.

The system shall cater for “N-1” meaning consumers are not affected by a loss of a component.

A/B routing of cables to consumers shall be segregated by distance and enter the room or area where consumer is located from different angles/sides.

It shall be possible to perform all maintenance and inspections on the A and B systems respectively without impacting the other system or requiring outage on HV systems.

Each auxiliary system A and B consist of the following main elements:

- Earthing and auxiliary transformer (EAT)
- Main LV switchboard and sub-boards for distribution and associated control and protection system
- UPS system including both AC and DC system
- Incomer for external power:
    - Back-up diesel generator connected to the bus-tie connecting A and B LV main switchboards
    - A temporary diesel generator (DG) connection box for connecting external power from a temporary DG, transported by CTV or SOV. The temporary DG box is connected to the back-up diesel generator switchboard.

Please see Figure 3. for an indicative SLD (Single Line Diagram) for the offshore auxiliary electrical system.

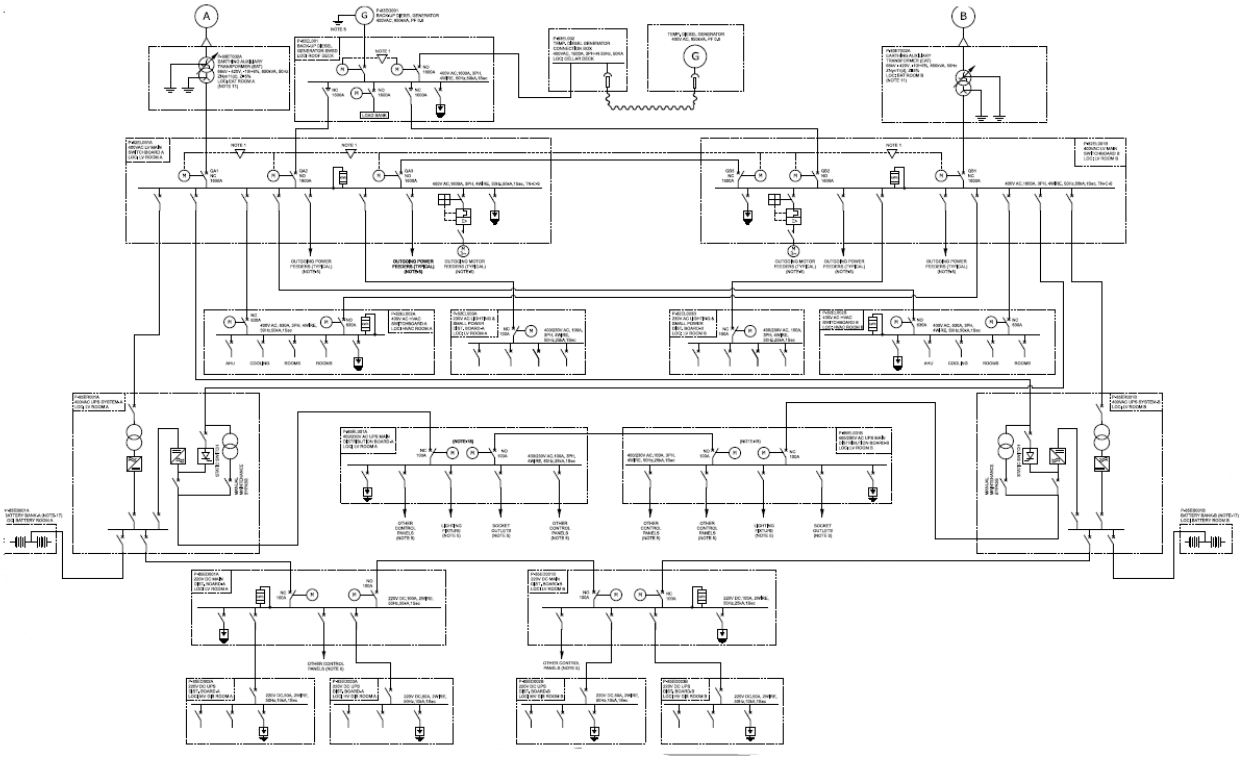


Figure 3. Single line diagram for the offshore auxiliary electrical system

Main LV switchboard and UPS main AC and DC distribution board shall have interconnection facilities between system A and B. The interconnections shall be possible to operate locally and from onshore CCR (ESI SCADA).

Final circuits from auxiliary electrical system and UPS system shall cater for a room-by-room shutdown for rooms having facilities for early fire detection (high sensitive smoke detection) via motorized MCBs controlled manually from onshore CCR (ESI SCADA).

No part of the electrical systems shall have arc incident energy above 8 cal/cm^3. This requirement shall be documented by arc flash hazard analysis according to IEC standards for main LV switchboard and distribution boards.

6.5 2Location of Electrical equipment

Equipment associated with A system and B system on HV, LV and UPS shall be separated in respective rooms or by distance if outdoors. A-equipment can be grouped together in same area/room, and similar with B-equipment, e.g. “A” system main LV board and “A” system UPS in one room.

Further details regarding location and layout see chapter 12.

6.6 3Power system characteristics

The power system characteristics define nominal values and deviations in voltages and frequency, harmonic content, and other parameters, during normal and transient conditions. Polish rules and regulations, followed by

company technical specific requirements and IEC standards, shall be followed and to be documented in the study intent document (ref next chapter) for the different voltage levels and systems used on the OSS.

All equipment and services shall remain operational within the identified range during all modes of operation and fault conditions that may occur.

6.7 Electrical philosophies, studies, calculations

Relevant electrical philosophies, studies and calculations shall be performed according to appendix A and TR3026, and to relevant Polish rules and regulations, confirm system design and selection of equipment and cables.

The main HV system philosophies, studies and calculations are covered in ESON Contractor scope. ESON Contractor is the main electrical system responsible and will give input where required to the Auxiliary Power System studies done by Contractor. Contractor will give input to the HV system studies where relevant. This will be handled in interface requests between Contractor and ESON Contractor.

A study intent and study outline document shall be delivered for each of the studies and accepted by Company prior to start Work.

6.8 Protection and Control

All final circuits in switchboards and distribution boards, and circuits between distribution boards and sub-distribution boards, shall as minimum have the following protection:

- Short circuit protection
- Overload and/or overcurrent protection
- Earth fault protection (not required in IT-systems)
- Earth isolation monitoring and/or protection (only required in IT-systems)

Upon event of black-out an evaluation shall be done if feeders shall be automatically disconnected (undervoltage trip). The platform shall be autonomous, and all auxiliary services/platform services shall automatically and sequentially start and return to normal operation upon return of main power and, where relevant, upon start of diesel generator.

All feeders, motor starters etc. shall be designed for restart after loss of supply, caused by disturbance or fault conditions which are cleared within the defined fault ride through of the HV system. Such loss of control voltage shall not imply any trip of services.

6.9 Earthing

6.9.1 Main earth

“Main earth” is the main, continuous structure of primary and secondary steel which is welded or otherwise have a solid permanent connection to the general structural mass of the installation. The substructure foundation is either piles or suction buckets which generally give a low impedance earth connection. The PE-system, IE-system and equipotential bonding is established from the main earth.

The system earth connection to main earth shall be through a separate main earth cable onto an earthing boss/bar welded to the main earth. The earthing boss/bar shall be located as close as possible to the equipment without risk of corrosion and other damage and with access for inspection.

In general, all rooms shall have main earth boss/bar which establish relevant earthing systems. Only one conductor is allowed on each earthing terminal point. If IE earth is required, it shall be established from a separate main earth boss/bar with minimum one meter distance from other main earth boss/bar.

Main earth bars shall be made of copper. Main earth bosses shall be made of AISI 316 L stainless steel. In outdoor and naturally ventilated areas, after connection, the whole assembly shall be sealed in to maintain the contact and prevent corrosion.

Guidance note: An aerosol based compound, making a waxy or rubber/resin based and tough film is preferred for sealing purposes.

6.9.2 PE system

Earthing and bonding practices shall follow IEC standards unless Polish requirements are stricter. All equipment running on a voltage above 30 V AC or 50 V DC shall have “supply” of PE. The “PE-supply” means equipment is earthed to the platform PE system.

The PE-supply shall be continuous from main PE earth boss in main LV boards to final consumer.

The PE-supply shall be made of copper.

PE conductor cross-section shall as a minimum be as listed by applicable IEC standards.

PE earthing of main equipment located indoors can be to local earth boss in room but shall also be connected to platform PE system through PE-supply in power cable.

Equipment supplied by single conductor AC cables or DC cables shall be connected to PE by a separate earth cable. The separate earth cable shall run alongside the power cables to form a "cable system" and shall be terminated to the consumer end earth terminal as well as to the feeding end earth bar/terminal.

The screen and/or armour braiding for single conductor cables and DC cables shall not be directly earthed in both ends due to circulating currents. - Earthing in both ends shall be evaluated in following cases; Single core cables where long lengths and current can cause high voltage in an unearthed end. Single core cables with both ends in hazardous area. Induced currents in the cable braided armour or other metallic covering shall be documented for safe operation. EMC requirement

The screen/armour in the non-earthed end shall be terminated and marked “Armour braid/screen is earthed in other end”. This can be omitted if the circulating current is included as part of the derating of the cable and/or the resulting voltage at non-earthed end is too severe.

The PE earth cables and/or braided armour of cables shall be connected to a PE earth bar as close as possible to the cable entry of the switchgear, cabinet, equipment etc

The auxiliary system main earth shall be located in the first main LV distribution board, providing a TN-C-S (combined neutral and earth) system fromEATs and diesel generators up to this point. From here a PE distribution system with TN-S (separate neutral and earth) is established, either via the power cables or separate parallel PE cables, throughout the distribution system, continuous from central end to field end. Separate earthing single line diagram shall be delivered to show the continuity of PE through the LV systems.

6.9.3 IE system

To avoid disturbances and voltage surges into instrument and telecom systems due to EMC and earth faults from LV system, a separate Instrument Earthing (IE) system shall be established. This earthing system shall be connected to main earth with minimum 1m distance from other PE earth connections and kept isolated from PE and other bonding to earths throughout the facility. IE bars in individual cabinets and equipment shall be installed on isolated standoffs, with cable run back to main IE system. IE cables to main system shall comply with IEC standards.

The IE system shall:

- provide zero voltage reference to instrument and telecom equipment/systems
- earth the zero phase in DC systems less than 50V
- earth the shielding on all cables carrying analogue or digital low energy signals below 24V

When implemented to earth screen in cable, it is earthed to IE bar at central end, but kept floating in field end. For cables between to “centrals” it shall only be earthed to IE bar in one end.

Guidance note: The typical 220 VDC control voltage for P&C is sufficiently robust and does not need IE earthing. Signals on mA and mV not used for tripping & alarm and/or running or controlling the plant, but only for indicative readings for Control room, may be without IE earth. This is typically the 4-20mA signal from transformer oil temperature.

6.9.4 Equipotential bonding

All metallic parts of plant shall be equipotential bonded to structure/main earth as per industry practice. Bolting or welding to structure is accepted as bonding.

6.9.5 Lightning protection system

Requirements for lightning protection is given in Appendix E.

Lightning protection of all equipment and personnel on roof deck shall be verified by the rolling sphere method. Separate system for lightning protection is normally not required, provided the steel structure is regarded as equivalent with the main earth and the structure is solidly grounded to sea/seafloor.

Antennas, cranes and other exposed parts shall be sufficiently bonded to main structure, if not satisfactory earthing is achieved separate earthing conductors shall be installed. It shall be considered to protect such equipment with local air terminals.

If there are risk for personnel with respect to lightning the relevant area shall be protected with local air terminals.

6.10 Electromagnetic Compatibility (EMC) and Electromagnetic Field (EMF)

6.10.1 EMC

An electromagnetic compatibility (EMC) study to plan and perform EMC measures for the OSS shall be established.

The study shall minimum contain

- EMC requirements
- EMC input data
- EMC analysis
- EMC measures
- EMC verification

General EMC planning shall be in accordance with IEC60533 and Polish rules and standards. The resulting EMC mitigation plan shall be reflected in procurement of equipment and installation procedures.

The installation of cabling to and EMC earthing in equipment and cabinets shall adhere to IEC60533 and Polish rules and standards. In general, the EMC earthing of cables and cabinets shall be according to the manufacture's recommendation as long as these recommendations fulfil the EMC requirement.

Guidance note: Inside cabinets/panels the inner screen and armour should be connected to the earth without using a pig tail. Pig tails can add high impedance to the screen/armour which in turn, through EM coupling, increase noise in conductors.

6.10.2 EMF

An electromagnetic field (EMF) study for the OSS shall be established.

The electromagnetic field (EMF) study shall document the EMF levels on the OSS to ensure levels are within acceptable limits according to Polish rules and standards.

Where mitigation is required the relevant EMF levels shall be documented before and after the mitigating action. The documentation shall include plot plans showing the EMF levels.

6.11 Lighting design

The lighting design shall adhere to Polish codes and regulations. Where conflicts arise, the most conservative criteria shall be applied.

The lighting system design shall have the following design goals:

- simple reliable system
- standardization on as few as possible light fixture types. The number of types and types shall be approved by Company
- LED light fixtures shall be used
- Minimize light pollution in unmanned mode

The light system on the offshore platform is divided into

1. Main lighting
2. Emergency lighting
3. Special lighting

When designing the light systems, it shall be a meshed system where e.g. every other light as an 'system 1' and an 'system 2B' along walkways, and minimum one light fixture each in every room.

It shall be evaluated from a cost benefit perspective to combine light systems 1 and 2 to a single system fed from the DC UPS where 50 % of light fixtures are connected to each of the two redundant UPSs.

Access for maintenance to lights shall avoid use of scaffolding or involve risk for falling overboard and outboard work. Any fixture 2m or less from outboard shall be maintainable from ground level by use of breakdown poles or other Company approved methods. All other fixtures shall be accessible directly from deck level, platform landing, or maximum 4m ladder. Method for access shall be documented in relevant maintenance procedure reflecting the location of the light fixtures.

All MCBs feeding light circuits shall be monitored by trip contacts with alarm in ESI SCADA. The trip contacts shall be grouped together forming logic groups to limit the number of alarms.

All MCBs feeding light circuits shall be type B to protect against AC, pulsating DC and smooth DC fault currents.

The light design shall adhere to local rules and regulations regarding light pollution. In general, all outdoor lights, or indoor lights visible from outside, shall be off except for navigational lighting (aviation and obstruction lighting) during unmanned mode.

Light circuits controllable by a ‘manned/unmanned’ switch, shall have the following functional requirements:

- ‘manned/unmanned’ switch physically located so it is easily accessible for personnel to/from SOV transfer and CTV transfer
- controllable via ESI SCADA from CCR, and its status shall be visible in HMI
- while the SCADA control method will turn the switch on/off immediately, the manual switch shall have one (1) hour trigger delay to facilitate safe transfer off the asset
- If there is any other ‘manned/unmanned’ facilities on the platform, e.g. for the ventilation system, it shall be combined with this switch

Main lighting

The main lighting system shall be fed via the normal distribution system and may be connected to auxiliary electrical system A or B only.

The main lighting shall cover approximately 70 % of the light fixtures.

All main lighting circuits shall be controlled by the manned/unmanned switch.

Indoors lighting for humans working place shall be according to IEC 61892-2 and EN 12464-1

Outdoors lighting shall be according to EN12464-2

Emergency lighting

Emergency lighting is defined as emergency consumers and shall be fed from the UPS system with duration as listed in Table 4.

Reference is made to /17/ PS 11.

For practical or economic reasons, the emergency light fixtures used to cover escape routes may be equipped with internal batteries instead of UPS supply but shall be subject for Company approval. If internal batteries are utilized instead of central UPS, the batteries shall be located such that they are not subject to excessive heating from the light fitting. It should also be possible to replace the batteries without dismantling the light fitting.

The emergency lighting shall cover approximately 30% of the light fixtures.

The emergency lighting shall provide sufficient lighting. Minimum average lighting levels shall be 10.8 lux and not less than 1.1 lux at any point. Minimum lighting level along escape routes shall be 1.1 lux, however at high risk task areas such as muster area, heli-hoist area, embarkation areas and evacuation areas it shall be minimum 15 lux.

Emergency light circuits shall be controlled by the manned/unmanned switch, except when covering escape routes. External fittings/circuits shall in addition be controlled by a fail-safe luminance sensor.

Emergency light circuits for indoor escape routes shall not be controllable and is always ON. Emergency light circuits/fittings for outdoor escape routes shall be controlled by a fail-safe luminance sensor.

Emergency exit signs shall either have an illuminated or fluorescent type of design. Illuminated exit signs shall be illuminated to a surface value of at least 54 lux. Self-luminous or electroluminescent signs shall according to EN 1838 and EN 13032-3.

Special lighting

Special lighting systems shall be designed according to local/national rules and regulations and standards (IALA O-139). Navigational aid lanterns shall be LED type, located on all four corners at a consistent height, synchronized flashing, and accessible for maintenance without over-water work. Fog horn shall be located away from the muster and multi-purpose areas described in chapter 3.1.3.

6.12 Sockets

Oil filled transformer rooms shall be equipped with correctly rated socket to facilitate oil treatment systems.

Diesel storage area shall be equipped with correctly rated socket to facilitate diesel treatment systems.

High rated three-phase socket outlets shall be provided in appropriate locations for reasonably foreseeable tasks.

Small power sockets for e.g. hand tools, portable lights, shall be available in every room and outdoors at various working areas. In general, all areas shall be reachable with a 25 m flexible cord without passing through doors or deck levels.

Generally, the sockets shall be fed from the main distribution system, however some strategic sockets in useful locations shall be fed from UPS. Sockets used for ESI SCADA workstation, WTG SCADA workstation and important engineering workstations shall be powered from UPS.

Sockets shall in general not be used for any permanent equipment, except for workstations and similar, and may be treated as zero load in load lists.

Each workstation location shall be provided with a minimum of two double AC sockets.

6.13 Auxiliary Transformers

The auxiliary transformers are combined earthing and auxiliary transformers(EAT). The voltage level for the EATs shall be 66/0.42kV,and are delivered by the ESON contractor. The EATs require protection and disconnection facilities on both HV and LV side.

Each of the EATs shall be rated to cover the entire load on the OSS with at least 15 % allowance for load increase during the lifetime of plant. The load shall be given as input to ESON contractor as per the interface document listed in Appendix E.

6.14 Main LV switchboards and sub-boards

LV distribution shall be a combination of switchboards, distribution boards, motor control centers (MCC) and panelboards, to be according to IEC61439, IEC60947 and IEC61892 and optimized by Contractor. The voltage level shall be 400/230 VAC and 220 VDC.

The main LV switchboard on system A and B shall be a switchgear, switchboard or MCC type as per the above standards (noted herein as main LV switchboard). .7. Arc resistant protection shall be maintained during breaker racking or cubicle withdrawal operations, as applicable.

It shall be possible during full production to isolate any single LV bus (switchboard, panelboard, etc) with zero potential at the line side of incoming/tie breakers and load side of feeder breakers. All breakers and fuses on distribution boards shall have provisions for a padlock without the use of separate accessories

The two main LV switchboards shall include facilities to be operated manually from local control on switchgear and via ESI SCADA from CCR. No automatic connection A and B system.

The LV system shall be designed for parallel operation of diesel generator, EATs and a temporary diesel generator connected to socket system.

The main LV switchboards shall have facilities to autonomously receive control voltage upstream of circuit breaker from any of its incomers, including bus-tie, in addition to the UPS control voltage. The changeover between the control voltage sources shall have status indication, block functionality and manual selection at switchboard and via ESI SCADA from CCR.

Main LV board and sub-boards shall have status indication and remote control of all incoming main breakers and bus-ties via ESI SCADA. Main power feeders and MCCs toward HVAC system, platform crane, davit cranes and UPS system shall have remote control via ESI SCADA.

All outgoing circuits from main LV switchboard shall have individual status indication to ESI SCADA.

Circuits from sub-boards shall have individual status to ESI SCADA for single consumers, while circuits covering lights, sockets and other similar consumers can be grouped to one status in ESI SCADA.

EAT incomers to main LV switchboards shall be equipped with synchronization facilities to enable seamless transition from island mode with diesel generator as power source to normal mode with grid connection, ref chapter 4.4.

For switchgear, switchboards and motor control centers: Individual breaker sections, cubicles, and outgoing power cable terminals shall be isolated from each other and the bus. The bus shall be isolated from wireway sections. Withdrawable breakers and cubicles shall have shutters.

6.15 UPS system

The UPS system shall be the OSS emergency power source and shall be sized to cover all emergency services in addition to all other non-emergency services requiring stable, uninterruptable, power supply. No emergency diesel generator shall be installed (only a backup diesel generator),

Reference is made to /2/, Table 5-2 (Table 4 herein), for emergency services but with the following amendments:

*Table **4**. Battery system back-up time*

Service	*Duration of battery back-up power [h]*
Emergency Lighting	3
Navigational lights	96
Structure marking	96
Active fire protection	18
Control and Communication	3
Alarm Systems	3

Navigational lights and structure marking, including aviation lights, fog horns, shall be fed from separate independent battery systems covering the 96 hours duration. FAS/FES shall be fed from separate independent battery system covering 18 hours.

All other services require emergency power supply or stable, uninterruptable, power supply shall be fed from a redundant set of UPS battery systems with 3 hours back-up duration each for the respective A or B side,. All consumers connected to UPS shall be connected to both UPS systems with local change-over as required, ref 5.3.

The two UPS systems shall be independent, redundant and located in separate rooms from each other, and each UPS system shall include a main DC distribution board and a main AC distribution board. Each charger shall be rated for both A and B UPS fed loads, in addition to the charging of batteries on the respective side. The UPS unit shall have a static switch arrangement for automatic no break transition to bypass supply in case of inverter failure, short circuit, voltage out of tolerances on the secure bus. No change-over/dual supply is required to each UPS charger but each of the two UPS chargers shall be fed from A and B main LV switchboard, respectively.

The UPS systems shall supply all control power on the OSS. This includes, but is not limited to, control voltage supply to platform crane, davit cranes, HVAC system, CCTV, access control systems, HV and LV P&C etc.

The UPS AC and DC main distribution boards shall be equipped with motor operated MCBs controllable via ESI SCADA for all outgoing feeders. All outgoing feeders to consumers shall have individual status indication to ESI SCADA. The grouping of consumers fed from each MCB circuit shall be selected such that the operator may disconnect/connect selective services without affecting other services. Example is the disconnection of the 66 kV GIS control and protection systems for export circuit A. Another example is the disconnection of the “B system” HVAC.

The UPS system shall have black start capability. This means that start-up of the UPS system with only battery supply available shall be possible. There shall be a manually operated switch in the battery breaker panel to override shutdown signal and to provide necessary control voltage to operate (i.e. close) the battery circuit breaker.

The UPS shall not generate high individual harmonics into the mains. Need for harmonic filter must be studied and installed if required.

Battery system and battery breaker

Boost charging facilities of batteries shall not be implemented.

Throughout the lifetime of plant, the battery system shall be able to supply the consumers for the required period with ambient temperature of 0°C. The battery charger shall have sufficient rating to recharge the batteries from 0% to 80% within 10 hours while the system has normal load. Battery rooms shall be provided with overhead or

cart-style battery hoist; manual operation is acceptable. Material handling study shall evaluate full replacement of batteries.O&M documentation for battery replacement shall be delivered regardless of chosen approach.

The battery distribution system shall be considered when calculating the capacity of battery system. All cabling and conversion systems between the batteries and final consumers shall be correctly sized to ensure minimum required voltage is maintained at the end of required period.

At end of specified standby period the battery system shall be able to supply the maximum tripping load. The trip which gives the worst-case battery load shall be identified.

The Battery system shall be provided with a battery circuit breaker which will automatically open on under voltage and retain enough capacity to facilitate a black start of plant. The required capacity shall be documented in black start procedure and included in the battery capacity design.

The battery breaker shall also be remotely monitored and controlled via dedicated PLC's and ESISCADA.

SMC battery type shall be used.

Battery cubicles/panels shall be designed such that there is sufficient and safe access to each individual cell for measurement and test purposes. This may require front and rear access. This may be achieved by utilizing battery racks.

An online battery cell monitoring system is required for condition monitoring of battery system.

Battery cables

All battery cable installation shall be short circuit and earth fault proof.

Single core cable with copper braid armour and isolating outer sheet shall be used. In battery end armour shall be sealed off and in battery breaker cabinet end the armour then shall be terminated on spare isolated terminal.

This installation shall facilitate to test that both barriers (conductor-armour and armour-ground) are healthy.

7 Instrument and Automation Systems

7.1 Automation and SCADA system

The offshore substation shall be equipped with a Safety and utility system (SUS) which will be a common term for all automation systems on the offshore substation.

The SUS shall be integrated with the ESI SCADA via a Firewall/Communication Gateway, and it shall be possible to control and monitor the different automation systems on the offshore substation from the ESI SCADA and further by the Top-Level SCADA system in O&M (CCR) building.

The SUS systems shall have dedicated local Programmable Logic Controllers (PLC)/Logic Solvers, which shall include all logic, monitoring, diagnostics, alarm and command functions for all utility systems and shall be designed in accordance with relevant Polish regulation's, Automation Technical and Functional requirements C256-EQ-J-SP-00002 /21/ and Appendix E documents.

The SUS system shall have required interfaces to I.e., CCR, ESI SCADA, TSO (Transmission System Operator), WTG SCADA, Company IMS system, Condition monitoring systems, 3rd party equipment for wind farm assets

and shall be designed in accordance with relevant Polish regulations, Automation Technical and Functional requirements C256-EQ-J-SP-00002 /21/ and Appendix E documents.

The SUS shall include the following functions/subsystem, but not limited to:

- SAS Node
- Emergency shutdown (functions)
- Fire detection (FiDe) system and equipment
- Firefighting (FiFi) systems and equipment (automatic and portable)
- Heat, ventilation, and cooling (HVAC) system
- Diesel generator
- Crane
- Process system including
    - Diesel system
    - Cleaning water system
    - Drain system
- PDCS systems
    - Low voltage power control/Power management system (PMS)
    - UPS system
    - Diesel generator

SAS/SUS node/PLCs and PMS node/PLC shall be of logic solvers type including control application according to IEC 61131-3 Function Block Diagram requirements as defined in Automation Technical and Functional requirements C256-EQ-J-SP-00002 /21/, and appendix E documents. All logic solvers within a system of the SAS/SUS shall be of the same product family/type, which shall be approved by Company.

Emergency shutdown function shall be implemented by use of logic solvers.

The SUS shall include a dedicated redundant SAS node/PLC containing function for handling of all interaction/trips between the different SUS system nodes.

Sufficient redundancy both on equipment and network shall be implemented to ensure that the safety, control, and monitoring functions will be maintained if a failure is detected are not repaired or changed immediately. This to ensure that repair or change out can be postponed until next planned maintenance campaign.

Redundancy shall be evaluated based on the following:

- Production availability requirements
- Consequence classification

- Operational criticality
- Modification requirements, like online configuration

Integration to ESI SCADA and SUS Nettwork design shall follow the principle as defined in overall Automation/IACS Network Topopology drawing C256-EQ-J-XI-00001-01 using redundante Gateway/Firewalls for integration of SUS network into ESI SCADA network.

The SAS/SUS network shall be built using fully managed network switches, all the same brand and compatible.

Error detection on the SAS/SUS network shall be fast (within the application cycle time) and reliable.

It shall be possible to replace redundant components in SAS/SUS during normal operation of the system, without any loss of functionality or production.

Real-time and historical data from all systems shall be available in Company IMS system via OPC-UA protocol.

Single MiniRTU for interface of each SUS equipment shall be avoided.

PDCS system

In additional there are the PDCS system containing:

- Low voltage power control/Power management system (PMS)
- UPS system
- Diesel generator

The PDCS equipment shall be connected to ESI SCADA via the SUS network via agreed protocols as defined in appendix E documents.

Alarm, control signals, analogue values, events, logs, fault records and conditions shall be collected from each LV switchboard, UPS and diesel generator by use of local control units, distributed I/O units or intelligent units with communication to ESI SCADA.

The PDCS equipment shall also have management function for remote management, troubleshooting and maintenance via a dedicated ethernet port.

There shall be a dedicated PMS node/PLC containing functions and logic for handling of all interaction/trips between the different PDCS equipment's.

Protocols

Protocols for communication to ESI SCADA shall be as defined in Automation Technical and Functional requirements C256-EQ-J-SP-00002 /21/, but with the following preferred protocols:

- OPC-UA

- Profinet/Profibus
- Modbus TCP

Communication interfaces:

The SUS shall be equipped with minimum two ethernet ports, one connection to ESI SCADA via SUS network and one for connection via Technical network for remote management.

Dedicated SFP for fibre connection shall be included.

Remote support:

Required functionality including management function/services and network ports for remote operation, monitoring, remote maintenance, troubleshooting, SW updates and service of all SUS equipment shall be included and designed in accordance with Automation Technical and Functional requirements C256-EQ-J-SP-00002 /21/ and Appendix E documents.

Patching and file transfer Back-ups.

The SUS system shall implement functions and required interface/connection for file transfer, patch and anti-virus updates/distribution and backups as defined in Automation Technical and Functional requirements C256-EQ-J-SP-00002 /21/ and appendix E documents.

Backup of all files shall also be available on common backup server on P drive WP01.

Cyber security design for all SCADA, control and monitoring systems shall be included according to Cyber Security Design Requirements C256-EQ-J-SP-00006 and Appendix E documents.

8 IT/OT infrastructure design and cyber security

Cyber security design for all SUS systems, and monitoring systems shall be included according to IEC62443, Cyber Security Design Requirements C256-EQ-J-SP-00006 and Appendix E documents.

Proforma document for IP-adresses, network LAN, ports, protocols, risk assessments shall be delivered on agreed restricted Cyber area in i.e. Sharepoint, not in PIMS. Only frontpage to be delivered in PIMS.

9 Telecommunication systems

Telecommunication systems with required interfaces, and related data networks, shall be designed in accordance with Appendix E documents.

Reference to project Telecommunication Technical specification /10/.

Cyber security design shall be included for all telecommunication systems according to Appendix E documents.

Documentation delivery is specified in app A SoW.

Additional telecommunication system shall be delivered as part of requirements given in radio expertise and military expertise from Ministry of National Defense and Ministry of Internal Affairs PL.The requirements are given as part of Technical Expertise report project documents (C274-PM-Z-RS-00007, C275-PM-Z-RS-00007, C274-PM-Z-RS-00009, C275-PM-Z-RS-00009, C274-PM-Z-RS-00013, C275-PM-Z-RS-00013).Summary of the requirements are listed ,but not limited, to the following:

- Sonar Transponders as a part of hydroacoustic reconnaissance system to avoid collisions with submerged submarines.
- 'X' band radar with antenna system to identify flying objects in the vicinity of the wind farms
- Land-Ship communication (VHF Marine Radio), 300 MHz and 512MHz band, to be installed on Baltyk II OSS
- Ground to Aircraft Communication (VHF Aeronautical Radio), 225MHz and 400MHz band, to be installed on OSS

10 Material handling

10.1 Material handling philosophy

The material handling philosophy of the OSS shall reflect the safe and efficient design criteria and maintenance philosophy given in chapter 2.

The OSS shall be designed for safe and efficient material handling. Material handling shall cause no incidents nor accidents.

Material handling includes all lifting and transport of supplies, goods and equipment to and from, and within the OSS topside, in all phases of operation.

Means and methods for material handling shall be robust and reliable, suitable for an offshore environment.

Material handling should be handsfree and segregated from all other operations where possible and practicable.

Floor based solutions should be used instead of lifting in air, whenever possible and practicable.

Lifting zones, laydown areas and transport routes shall be identified and located to minimize risk to persons, assets and the environment.

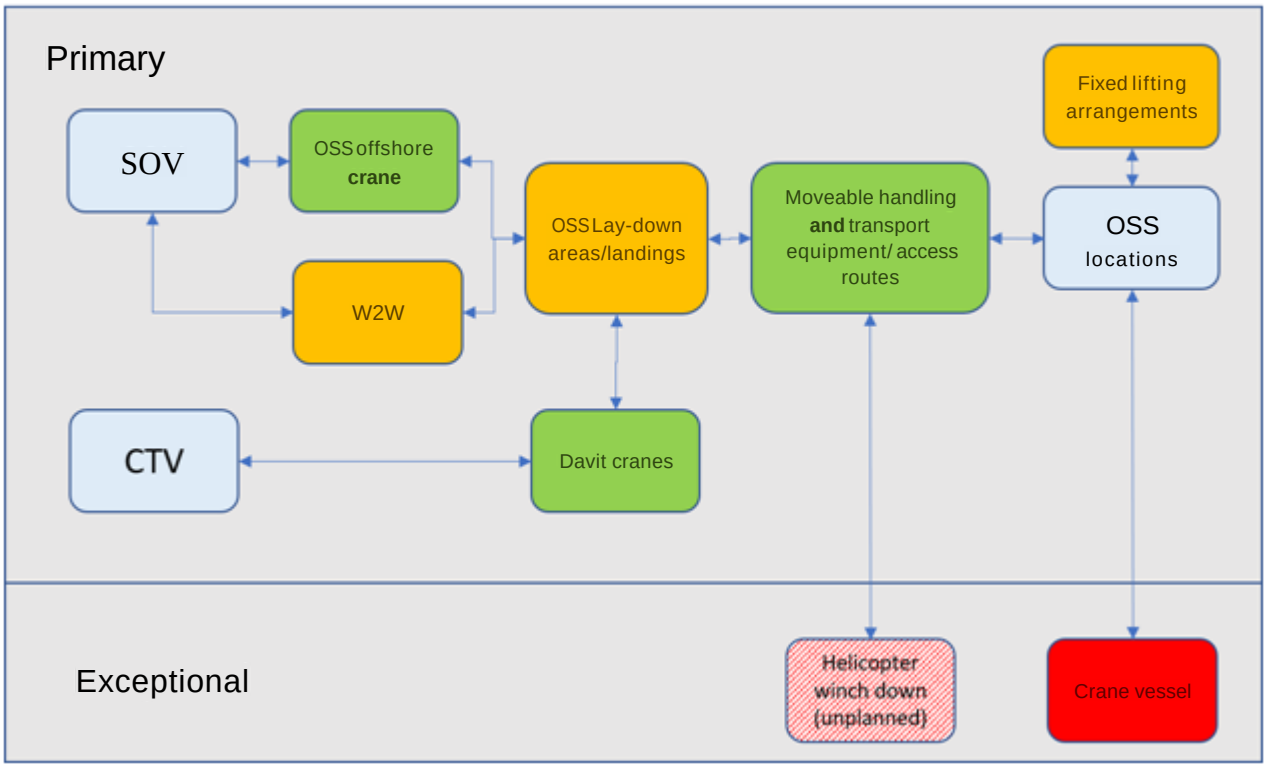


Figure 4. 4 Material handling philosophy, schematic

The material handling on the OSS comprises of the following categories of equipment:

a) OSS platform crane
b) Davit cranes and Jib cranes
c) W2W trolley
d) Moveable lifting/transport equipment
e) Fixed lifting equipment including between deck laydown areas

Overhead Gantry Cranes / Travelling Crane (if required). In addition, JUR crane (crane vessel) and helicopter winch down represents material handling options in exceptional cases.

All items that may need to be lifted or transported with weight above 25 kg shall have planned and identified means of material handling.

The elements of material handling on the OSS shall be studied, see figure below:

a) The material handling needs, and frequencies shall be analysed.
b) The means of material handling shall be adopted to the needs.
c) The means of material handling shall require a minimum of offshore maintenance and be ready for operation with a minimum of preparation whenever the OSS is manned.

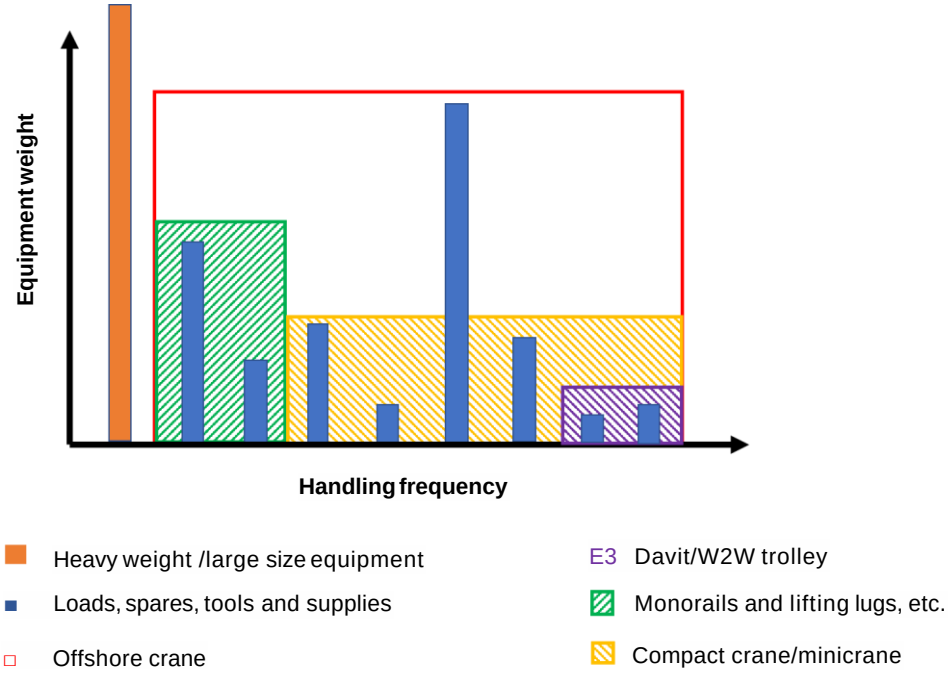


Figure 5. 5 Material handling needs and methods

Except for the platform crane and davits, the first priority material handling shall be moveable handling and transport equipment that can be brought from shore whenever needed. If, due to equipment size, weight etc., location, this is not practicable or safe, permanent means of material handling shall be provided, or alternatively in exceptional cases, the use of a crane vessel shall be described.

The material handling landing areas, layout areas and routes shall be designed for efficient and safe operations and enable standardized material handling solutions.

Material handling equipment shall be standardized and selected such that the need of any special personnel certification/special training is minimized.

The material handling routes including laydown and landing areas shall be sized to facilitate transport of the heaviest/largest equipment and shall be without any thresholds or obstructions.

The material handling philosophy shall be the basis for the material handling study and the material handling report.

Fixed lifting equipment shall be provided at each deck level for the routine lifting/transferring of cargo between deck levels, to minimise the use of the main platform crane and the inherent higher levels of operator competence required for its use.

10.2 Material Handling Study

A material handling study shall be performed based on the material handling philosophy and study by Rambøll OSS FEED.

The material handling study shall be based on the material handling philosophy and identify, select and describe the material handling solutions on the OSS, taking into account as a minimum:

- Layout

- Boat landings & W2W push on locations
- MEL and equipment specification
- Maintenace requirements
- Spares
- Packages, fixed and temporary
- Tools and supplies
- Means of material handling on the OSS
- Means of material handling and transport to and from the OSS
- Operational requirements

The material handling study shall be multidisciplinary and involve all relevant disciplines. The study shall ensure all the maintenance requirements/intervals specified by the HV/LV equipment supplier is accounted for and any special tools / access solutions (eg: scissor lift, boom lift etc.) requirements shall be detailed

The study shall take into consideration G+ Case study on material handling[2] and dropped objects[3], and other relevant publicly available G+ documentation[4].

The material handling study shall as a minimum include:

- Listing of applicable Governing requirements, rules, regulations, codes and standards
- Listing of applicable Company requirements
- Description how the material handling philosophy and operating requirements are implemented
- Analysis of the material handling needs, including categorization of equipment, spares, tools and supplies, by weight, size, location, frequency, load carriers and packing equipment needed to handle the equipment etc., and material handling means and routes
- Description and design criteria of means of material handling including cranes, davits, W2W trolley, fixed and moveable lifting and transport equipment.
- Description and design criteria for loose lifting gear, containers and baskets, also for cable pull-in operation.
- Description and design criteria included load distribution, point loads and drop loads for:
    - landings and laydown areas
    - transport routes
    - railings and buffers
- Identification of lifting zones and areas where lifting is not allowed
- Operational limitations for material handling including motions, wind, waves, temperatures, etc.
- Develop concept for crane location, laydown areas, storage areas and transport routes including size, location and capacity
- Secure sufficient Main crane hook clearance to top deck for container lifts.
- Secure sufficient area and structural capacity of laydown area at cellar deck, for removal or adding pendant wire for SOV lift with Main crane.
- Description of material handling equipment including sizing and capacities
- Definition of largest and/or heaviest item to be handled per area/room including description of its transport route, type of handling equipment used and method of material handling
- Risk of dropped objects shall be mapped and identified
- Description and design criteria for dropped object protection

[2] https://www.gplusoffshorewind.com/?a=699447
[3] https://www.gplusoffshorewind.com/?a=641042
[4] https://www.gplusoffshorewind.com/work-programme/guidelines

- Specify all cranes by type, size, lifting capacity, working area and lifting zones:
    - distinguish between routine lifts, critical lifts and engineered lifts
    - distinguish between safe-, restricted- and no- lifting zones
    - Need for swinging load protection, guiderails and bumpers to be identified
- Concept for lifting to and from CTV/SOV shall be developed
- Concept for handling of diesel bunkering from CTV and SOV and diesel storage/handling shall be included
- Concept for handling transformer drain tanks in case of oil leak shall be included
- Requirements for certification of lifting and handling equipment and requirements for any special training and certificates shall be identified and its OPEX cost taken into consideration.
- Concepts for material handling temporary generators / any black start generators during an outage (planned / unplanned)
- Maximum crane and telecom tower height shall be interfaced early in detail engineering phase, and shall not exceed limits sent to Polish authorities

Maintenance operations including material handling shall be demonstrated in the 3D model during detail engineering and documented in the material handling report.

The study shall also include handling, installation, operation and removal of a temporary cable pull-in winch on cable deck for installation or replacement of export cables or IAC during operations. Weight of winch shall be confirmed by relevant contractors and included in material handling report. Capacity of pull-in winch must be defined by cable contractor/pull-in Contractor with sufficient margin.

Secure correct number of monorail winches with rails in GIS rooms.

10.3 Material Handling Requirements

All material handling equipment is to be designed, manufactured, marked and documented in accordance with applicable Polish regulations.

All cranes and lifting equipment shall be certified before taken into use.

All rigging and transport equipment shall be certified before taken into use.

All material handling equipment shall be designed, fabricated and certified in accordance with recognized standards and the Contract.

The material handling equipment shall be robust and suitable for a harsh offshore environment.

The cranes and other permanently installed equipment shall be high quality, with high reliability and require low maintenance. The equipment shall be designed for sporadic use and long inactive periods without attendance and maintenance.

10.4 Laydown areas

Laydown areas shall be provided on all deck levels in accordance with the material handling study. Laydown area locations, sizing and lay-out shall be compatible with the need for material handling during the design life of the installation.

The laydown areas shall have direct access to transport routes and at least one area on each deck level shall have vertical load handling access within the reach of the platform crane.

The laydown areas shall be designed for relevant dynamic loads from the platform crane where applicable and any means of internal material handling on the topside.

All laydown areas shall be clearly marked. A sign indicating maximum weight and loading rating shall be displayed at each area. Sufficient space and access shall be provided for personnel to perform safe slinging/unslinging of the load, and to easy escape to safe position when needed. The laydown areas shall be of plated deck type with high friction.

The laydown areas shall be sufficiently sized to place and handle the relevant equipment in accordance with the material handling needs including any opening of container doors without blocking/obstructing escape paths or transport routes.

Guidance note: Minimum size for the laydown areas on each deck level should be minimum 4 m x 2,5 m and sufficiently sized to accommodate handling of relevant equipment according to the material handling study.

Laydown areas served by the platform crane

Laydown areas shall be provided on all deck levels, including the roof deck, accessible by the platform crane. The position of the laydown areas shall give the operator a clear view from the crane control station to the typical SOV/CTV deck locations and laydown areas for load handling.

Offboard lifting and vertical lifting with main crane shall be within the cable free zone.

Laydown areas on the different deck levels reachable by the platform crane shall be staggered and may be overlapping.

The laydown area on roof deck shall include a space for positioning and storing of at least two 10 feet containers, including space for handling, slinging, loading and offloading, by the use of the platform crane. Additional storage space for containers etc. shall be provided on roof deck to be used by a jack-up vessel crane during temporary assignments. Storage areas shall also facilitate lashing points for securing equipment and containers.

If an all-electrical platform crane is selected, the walk -to-work area north-east at Cellar deck shall also be used as a laydown area for the OSS platform crane. The area shall include space and sufficient railing and bumpers for temporary placement of one 10 feet container for installation or removal of the pendant wire, before lift to, or from SOV .

SOV W2W gangway access points

The SOV will be equipped with W2W gangway access system with an electric powered trolley for handling of loads up to 2 metric tonne and size up to Euro pallet (1200x800 mm). The W2W access point areas shall be designed to facilitate efficient handling of loads between the W2W gangway and the transport routes on the topside. The W2W access point areas shall have sufficient vertical clearance to allow for auto-rise systems and other such operations by the gangway system. *Guidance note: The minimum size of the W2W access point area*

is 4x4 m. The SOV gangway laydown area and the deck laydown accessible by the main crane area should be combined to one laydown area.

Davit crane laydown area

Next to the davit cranes for the CTV boat landing(s) a laydown area is required to handle goods to/from the CTV. Where the davit crane shall swing the goods onto the deck a gate solution shall allow for swinging in goods without being restricted by the height of the guardrail. The area around the gate and davit crane laydown area shall be prepared for fall protection systems when gate is open and fall prevention systems for operator required to handle the goods in this area.

The davit crane laydown area should be accessible by the platform crane.

Guidance note: The minimum size of the davit crane laydown area is 4x1,5 m. May be combined with other laydown areas.

Bumpers, etc.

Exposed and sensitive equipment shall not be located in laydown areas. Lighting fixtures and cables etc., shall either be protected or recessed.

Laydown areas shall be equipped with bumpers. The bumpers shall be rigid steel structures with sufficient strength to absorb impact energy for relevant material handling operations. This shall also include possibility to stop swinging loads and function as guides at laydown areas and at roof deck elevation. An example is shown in *Figure 6.*6.

Hand railing around lay down areas and adjacent structures shall be designed for relevant swinging loads.

Bumper structures shall be designed for relevant swinging loads and possible contact between crane boom and platform structure. Bumpers shall preferably have vertical orientation to prevent snagging of loads during lifting.

Figure 6.6 Example of bumper and guide structures

10.5 Transport routes

The transport routes, doors, hatches, and free space around equipment shall ensure that replacement of any equipment or part of equipment can be carried out as intended in a safe and efficient manner.

Transport routes should be without thresholds and facilitate step-less transport on each deck level. If thresholds are used these shall be removable.

Sufficient space and access around equipment shall ensure no shutdown of other equipment/systems due to material handling.

The transport routes shall minimum have sufficient space for handling and transport of a Euro pallet (1200 mm x 800 mm) to any laydown area or room on the topside. Final size shall be identified in material handling study.

Doors shall be sized and placed to accommodate relevant material handling. Where needed a removable hatch to extend the door opening is acceptable to facilitate transport of high items.

Vertical transportation within each deck level shall be preferably done with portable lifting appliances.

Lifting between decks shall be performed by crane between external laydown areas to minimize need for hatches. If required, hatches for transport of items between decks shall be provided.

Material handling of equipment less than 2 tonnes within the OSS shall be performed by horizontal transportation from the laydown areas to/from the target location by use of trolley along the transport routes.

For handling of items heavier than 2 tonnes, and size not suitable for the transport routes, separate individual material handling solutions shall be identified and documented.

Guidance note: It is expected the 2 tonnes indicated above shall cover handling of the heaviest component of the 220 kV and 66 kV GIS, which is a circuit breaker module. Also, the largest component of the earthing and auxiliary transformer should be designed to be within this limit.

10.6 Platform crane

Requirements for the Platform crane is given **Error! Reference source not found.**.

A platform crane shall be placed on roof deck to perform offboard lifting between the topside laydown areas and SOV cargo deck in relevant positions, one of the loading area of the CTVs located in push-on mode, and inboard lifts between laydown areas at all deck levels, as well as serving the main hatches.

The platform crane size and positioning shall ensure the following:

- Offboard lifting between the SOV and the topside can be performed in the cable free zone
- Necessary lifting height and reach to perform inboard lifting between dedicated laydown areas
- View from control station on platform crane shall be clear and obstruction free towards the laydown areas, CTV and SOV.
- Serve different SOV positions and headings to allow different wind and wave directions during lifting operations
- Be close to the outer end/corner of the topside layout to reach the SOV cargo deck with a minimum clearance between the SOV and any structure on the OSS shall be 10 m

Guidance note: The optimal position could be at a corner to facilitate load handling from different SOV positions and to give maximum reach towards the vessel deck and clearance between the OSS and the vessel during load handling.

The SWL rating of the crane is to handle the heaviest replaceable item (plus any shipping container & rigging required for that item) identified by the material handling study which may be required to be lifted to/from the platform along with containers and temporary equipment required for maintenance and commissioning activities.

Contractor to determine dimensioning load as part of material handling studies. As a minimum the platform crane shall have sufficient capacity and reach to lift at least 5 metric tonne (indicative number only – Heaviest component plus any transport container & rigging shall be the base) in Hs=3 m from the SOV cargo deck positioned with a minimum clearance between vessel and any OSS structure of 10m (to be agreed during FEED). The platform crane capacity and reach in H=3 m shall be based on material handling study and finally agreed during the FEED study.

An SOV width of 24 m shall be considered as minimum. The outreach of crane shall facilitate lift of container from midship of the SOV deck.

Roof deck shall be equipped with a fixed point for load testing of the crane (If possible Topsides lifting lugs can be designed to serve the function of the load test pad eye). This shall be dimensioned to at least 1,5 X crane maximum SWL.

The crane shall include a parking arrangement such that the crane boom can be secured, and its accessories and equipment are maintainable with access from deck level.

The height of the crane need to be interfaced with the antenna tower height, and maximum platform height given to Polish authorities.

10.7 Davit cranes (Boat landing cranes)

Requirements for davit cranes is given in **Error! Reference source not found.**.

Davit cranes shall be included for each boat landing on the substructure to lift goods between the CTV and the topside. CTV laydown areas shall be equipped with a fixed point for load testing of the crane.

The sizing of these cranes shall be based on the material handling study with a minimum lifting capacity 2000kg for a sea state of 2m Hs. Allowed size and weight of goods to be safely handled to/from CTV shall be documented.

The davit cranes shall be equipped with separate anchor point to facilitate use of emergency descender for lowering an injured person on a suitable stretcher to the CTV.

The davit crane operation shall be possible via a remote controller enabling the operator to have clear view of the entire lifting operation including the CTV loading area from safe position.

The davit crane shall be electrical driven both for hoisting/lowering and slewing, and with emergency load lowering and manual slew option in case of power outage.

The davit cranes shall be positioned perpendicular to the CTV centre axis, allowing the davit crane boom to swing along the length of the CTV.

Guidance note: The centre of the CTV cargo area shall be estimated to be 4 m from the boat landing fenders. This must be reviewed during FEED as some of the larger CTV's have a cargo area further back. *See Figure 7.7 as an indicative sketch of how the davit crane may be positioned.*

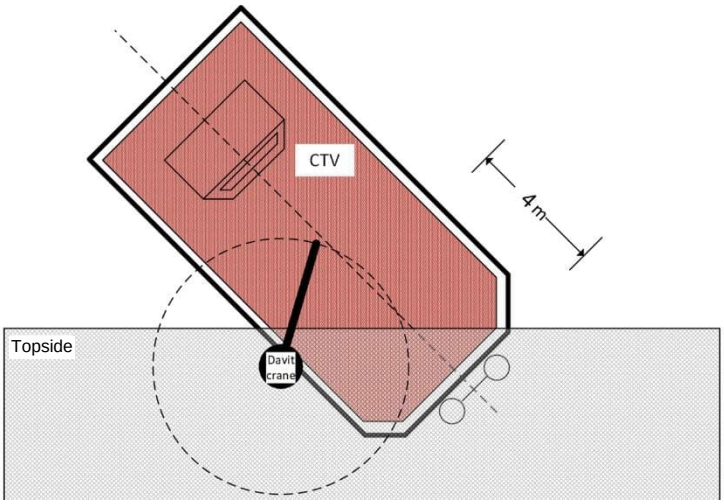


Figure 7.7 Indicative sketch of davit crane position vs CTV

10.8 Other lifting and transport equipment

Other lifting and transport equipment may consist of:

- Fixed monorails and lifting lugs
- Temporary moveable mini-cranes and A-frames
- Trolleys
- Pallet-jacks
- Lifting accessories
- Jib cranes
- Overhead traversing crane
- Etc.

Other lifting and transport equipment shall be designed, fabricated and certified in accordance with recognized standards and applicable Polish regulations.

Transportable, floor-based solutions shall be preferred instead of fixed lifting devices. However, where temporary floor-based solutions are not feasible or practicable, fixed overhead monorails for trollies and lifting lugs may be used.

Beam clamps Beam clamps shall not be used as primary means for lifting for material handling.

Where permanent lifting points or lifting beams are used these shall be attached to the structural steel by means of welding or bolting. All permanent lifting points shall be clearly identified and marked with tag-number and maximum rated capacity. Lifting lugs shall be designed for minimum 2 metric tonne.

Lifting points installed for the installation & commissioning phase but not relevant for the operational phase shall be decommissioned before handover to Operations. The lifting points relevant to decommissioning shall be kept in place physically but shall be specifically marked in the lifting register as ‘not for use’.

10.9 Equipment to be handled

Material handling facilities and equipment shall in principle be provided for supplies, tools, spares, equipment, removal and replacement of all components, needed for operation and maintenance of the installation.

All packages, equipment, spares, tools and supplies shall be designed and equipped for material handling, unless it is very unlikely that material handling will be needed during the lifetime of the installation or the weight is less than 25 kg.

Equipment that are beyond the capacity of the material handling equipment on the OSS due to their size and weight are for example:

- Large Transformers
- Other large items and assemblies

Such equipment shall be designed with means of access, lifting points and arranged to be lifted by a crane vessel. If necessary, hatches and horizontal access routes shall be provided. Equipment which are not suitable for “quick change out”/”plug and play” due to size or other constrains, shall be designed for partly replacement with a modular design such that splitting into smaller units can be done.

Each equipment packages shall be planned and prepared for material handling. This implies that each supplier shall provide arrangement for and describe how material handling in terms of lifting and horizontal transport of units shall be performed, and which equipment to be used. All equipment that is planned to be replaced, weighing more than 25 kg, shall be equipped with necessary lifting points, brackets etc. to facilitate lifting and transport, by standardised lifting accessories. For lifting by the platform crane and the davits, normally load carriers certified for offboard lifts shall be used.

10.10 Material handling report and Material Handling Data Sheet

The material handling report shall identify all equipment, spares and tools that is planned to be handled. The material handling report shall describe the weight, size, location, frequency, method, means and routes for all material handling between their destination locations and vessels.

The report shall be part of the operational documentation for the installation.

The material handling report shall minimum:

- Follow the material handling philosophy and study to detail the handling of individual, or similar groups of, objects to/from the OSS and internally on the OSS, to installed position, and back.
- The intended detailing level of the report shall be sufficient to be used as a work order during O&M when performing the equipment handling.
- Present material handling routes by 3D views from equipment location to laydown areas
- The report shall include handling for all planned regular and infrequent maintenance tasks, and replacement of entire units if damaged, for every item weighing above 25 kg.
- Describe all permanent and temporary means of material handling and associated lifting equipment including tag numbers (where required), sizes and capacities
- Description of standardized sizes of typical lifting beams, pad eyes and lifting equipment, as applicable.
- Requirements for certification and marking of lifting equipment including foundation and suspension
- Describe laydown areas, storage areas, transport routes, lifting zones etc.

- Description of function, size and location, maximum allowable loads, point loads of lay down and storage areas including areas for the handling of temporary, Company provided and hired equipment., (Laydown area chart)
- Requirements for transportation routes including maximum allowable loads, point loads, width and height in the different areas. (Transport routes chart)
- Description of loading hose handling including hose replacement
- Describe any operational restrictions or limitations for material handling
- Description and drawings of areas where special protection of equipment is required e.g. dropped object protection, truck barriers, swinging load protection etc.
- Drawings and visualization of topside layout and material handling solutions
- Details of any special tools, access solutions (scissor lifts, boom lifts etc), skid tracks / trolleys required (for planned / unplanned) for material handling any of items on OSS
- Material handling philosophies for planned / unplanned outage or black start events – covering topics such as handling of any temporary generators, black start generators etc.
- Material Handling Data Sheet . Material handling data sheet content shall be in accordance with TR2324
- Table /index containing all tags to be handled with corresponding identification number to the Material Handling Data Sheet.

11 Vessel interface to OSS

11.1 Service Operation Vessel (SOV)

The SOV will be equipped with a walk-to-work (W2W) gangway system positioned mid-ship to be able to give access from both sides of the vessel to the topside structure.

The offshore platform shall be designed to allow safe and efficient access from SOV's gangway system. This shall be considered as the primary means of access to the OSS during the construction/commissioning phase. In operation phase this will be the secondary means of access.

The topside shall be equipped with walk-to-work (W2W) access facilities at two (2) locations (each with two gates), which shall allow for safe transfer of personnel and minor spare parts directly from the SOW to the OSS.

The sketch below in Figure *8.* 8 indicates how this can be achieved. The exact orientation of the access points shall be based on an evaluation of relevant metocean data, global structure layout and operational experience to maximise access.

The gangway connection shall facilitate push on mode with industry standard design, with a U beam construction, brightly coloured red, and designed to enable replacement or installation of alternative retrofits. The design of gangway connection and handrails shall not limit the gangway to only provide perpendicular connection.

Sufficient space shall be provided around and vertical above the gangway landing/contact point to fulfil any auto-retract requirements of the gangway system.

Gangway landing access points and equipment located in vicinity of access points shall be positioned to ensure that an impact from the gangway in case of a DP failure will not lead to an escalating event, e.g. by causing damage to critical equipment, or impairment of main safety functions.

Each gangway connection shall have a landing plate and a hinged gate solution. The size of gates and landing plate shall be adapted to the final gangway design and material handling requirements.

The gates shall be easily opened and closed from the gangway position, with a locking mechanism on top of the gate for easy, quick and safe operation.

Sufficient prisms shall be installed on the OSS to ensure safe approach to each gangway access gate. The prism is to be of the retro-reflector type where the laser signal is returned for SOV DP positioning. There shall be clear view between the prism and the SOV. Example[5].

The SOV gangway system will have facilities for an electric remotely controlled trolley for material handling across the gangway from the SOV to the topside and vice-versa. This is intended to be used on all gangway connections. Hence, a transport route shall be established from the gangway access points. The transport route in the immediate area at the gangway access point shall be in a straight line to allow for quick dis-embarkment of the electric trolley onto the topside with no turning. The maximum cargo dimensions will be Euro pallet 1200mmx800mm and 2 metric tonnes in weight.

Sufficient space shall allow for stretcher passage from the platform to the SOV via the gangway access points.

Electrical continuity / earthing shall be provided to ensure galvanic balance between gangway system and platform.

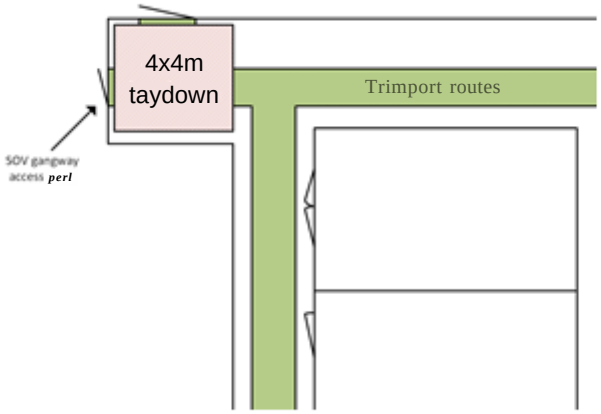


Figure 8. 8 Indicative sketch of gangway access points and gangway landing area

11.2 Crew Transfer Vessel (CTV)

Boat landing(s) shall be provided to allow access by way of CTV and/or Daughter Craft. CTV shall be considered as the primary means of access to the OSS during the operational phase.

Boat landing requirements can be found in /4/.

[5] https://www.guidance.eu.com/assets/_managed/ iles/New%20Brochures/94-0437-4-A%20Rugged%20Prism%20Brochure.pdf

Material handling to/from CTVs shall be facilitated by davit cranes and platform crane with associated laydown area on the topside, see 10.4 and 10.7.

Illumination at boat landing shall conform to Polish law but the operational preference is for CTV-based lighting of the boat landing ladder(s)to avoid blinding of vessel crews.

11.3 JUR/flotel

During temporary phases, such as hook-up and commissioning phase, a JUR or flotel may be used to support the offshore operation.

The position of the JUR/flotel will be in the cable free zone at platform at the east side.

The OSS shall include space and facilities for gangway landings to accommodate for gangway between the JUR/flotel and the platform. Removal of handrails and temporary structures to secure fall protection systems is accepted. The gangway shall be used for both personnel and material transfer. Two gangway landings shall be included in the design, one main and one emergency at different corners/decks, in case this is required.

The OSS shall have space on the roof deck to accommodate storage/laydown area during this phase which is accessible by the JUR/flotel crane. This storage/laydown area may be the same as the permanent roof storage/laydown area accessible by the platform crane if safe lifting can be performed.

Laydown areas on other decks should be accessible by the JUR/flotel crane.

Relevant loads, also considering loads due to relative motions, shall be and accounted for in the design of the OSS.

The OSS shall have facilities for integration of JUR/flotel systems with platform systems such as fire, PA/GA, auxiliary power and administrative and technical network. Hard wired signal cables shall be included in the design as required.

The OSS shall be prepared to receive all required auxiliary power from a JUR/flotel during temporary phases. When the OSS is connected to grid it shall be possible to supply all required auxiliary power to the JUR/flotel.

The OSS shall be equipped with a fibre cable routed from telecom room to a minimum 12 fibre patch panel junction box suitably located near the bridge landings to allow connection between the JUR/flotel and the OSS.

All cabled connections between the OSS and the JUR/flotel shall have quick release plugs and sockets located close to the gangway landing.

12 Layout

12.1 General layout

General layout requirements shall be in accordance with TR2324.

The TR2324 is complimentary and shall be applied in addition to applicable laws and regulations in the country where the installation is located.

The general layout shall insure that the arrangement and functionality provided by the layout satisfies all safety, construction, operations and maintenance requirements and that it is effective from a space, cost and weight perspective.

The layout of the OSS shall reduce the probability and the consequences of accidents through location, separation and orientation of areas, equipment and functions.

The topside shall be a “closed” design where all equipment is located indoors as far as practically possible, with external walkways and stairs providing access, escape and material handling.

The layout shall accommodate easy handling of equipment and materials. Replacement and maintenance of large equipment such as transformers shall be facilitated. The layout shall take material handling into account, reference is made to chapter 9.

All rooms/areas shall have main entrance toward external walkway for material handling purposes and simplification of escape routes.

Main transformers and earthing and auxiliary transformersshall be positioned in weather protected naturally ventilated areas. Auxiliary transformer, if dry type, shall be positioned indoor in HVACHVA/C controlled rooms. Hatches shall be provided to facilitate lifting of transformers through roof with a JUR crane.

The arrangement of HV equipment shall allow for minimum crossing of HV cables.

Duty/standby systems and redundant equipment and systems shall be located in separate rooms or separated by distance if outdoor, e.g.:

- All system A transformers shall be located in one separate transformer area, similar for the B system
- System A of LV system and UPS system shall be located in same room, similar for the B systems
- HV monitoring, metering and P&C shall be located within GIS rooms respecting the A and B split. The P&C of the HV equipment located in naturally ventilated area shall be located in either 220 kV or the 66 kV GIS rooms as far as practical possible
- Redundant systems of the SCADA network shall be in separate equipment rooms
- FiDe, FiFi, telecom systems, GA and other such platform systems shall be in separate equipment rooms if redundant systems are used

Example of layout based on the above bulletpoints are given in Figure 9 below.

In general, piping and cable racks shall be routed in such a way that it does not conflict with material handling and operational activities.

Accessibility for pulling of cables during construction shall be ensured when designing multi-level racks.

Pipes, cable racks, lighting fixtures, loudspeakers, detectors and other sensitive equipment shall not be located in and around laydown and gangway areas such that they are exposed to damage during lifting operations. In the event that this is unavoidable, adequate protection shall be provided for the items in question.

Piping shall be kept clear of manholes, access openings, inspection points, hatches, davits, overhead cranes, runway beams, clearance areas for instrument removal, tower dropout areas, access ways and emergency escape routes.

Un-insulated lines with the possibility for ice build-up shall not be run above walkways.
Accumulation of ice on elevated structures (cranes/ antenna etc.) and impact of falling ice shall be considered in the design

Water pipes or other liquid pipes shall not pass through rooms containing electrical, instrument or telecom equipment, this also includes areas above ceilings and below raised access floors.. When not possible to avoid, such pipes shall be without connections and shall include mitigation against rupture e.g. pipe-in-pipe solution.

Water outlets over sea shall be terminated in such a way that water splashing on supply vessels is

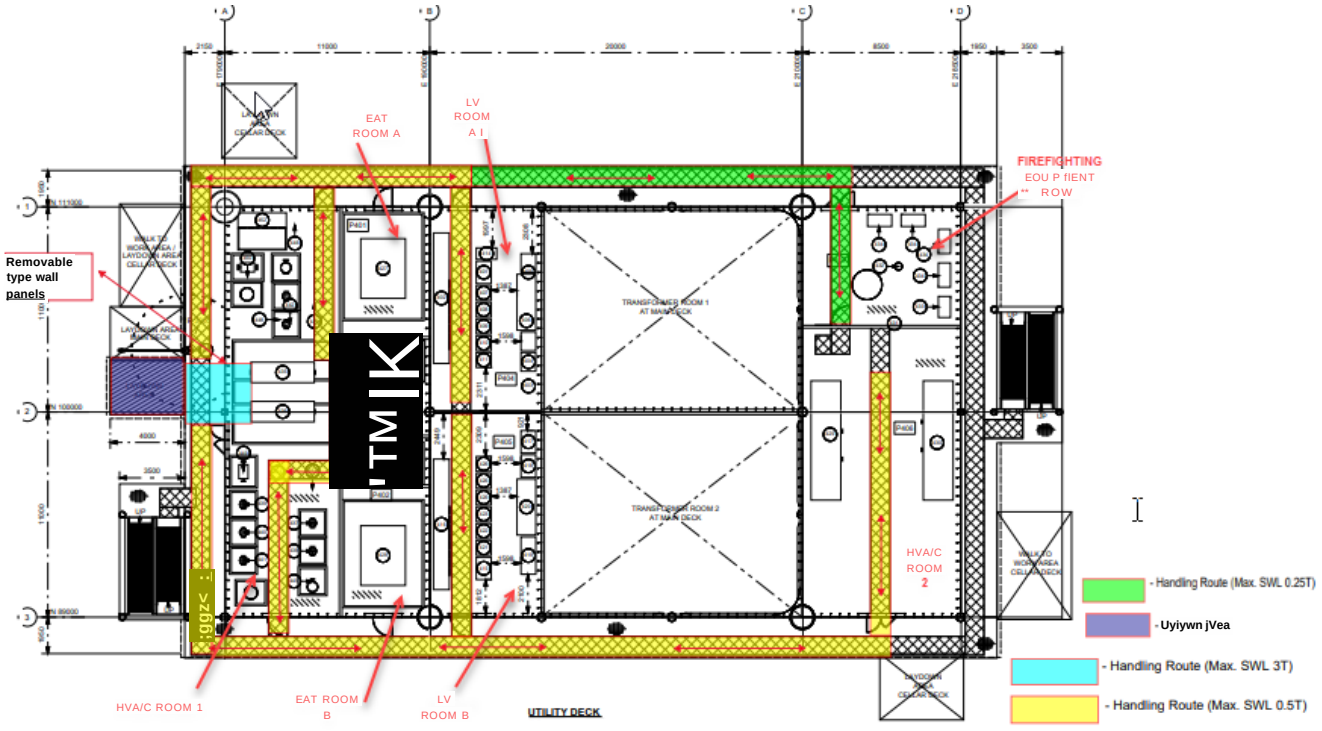
eliminated.

Permanent access shall be provided to all equipment requiring, as a minimum, yearly access.

Storage areas for liquids (lubricating oils, hydraulic oils, chemicals, hazardous waste, etc.) shall be designed to minimize risk of spills and facilitate collection of spills. Brackets fixed to decks shall be positioned so as not to obstruct flushing and cleaning of the deck.

Consideration shall be made to avoid or minimise risk from flying objects in an explosion (such as hatches, panels and loose equipment).

Topside lifting points for installation vessel shall accommodate access around for sling handling, a 3 m radius obstruction free zone should be maintained around lifting points, final clearance as agreed with installation contractor. Free height above J-tube flange after topside installed should be no less than 8 metres to ensure space for EC bending radius and shall be agreed with EC contractor.



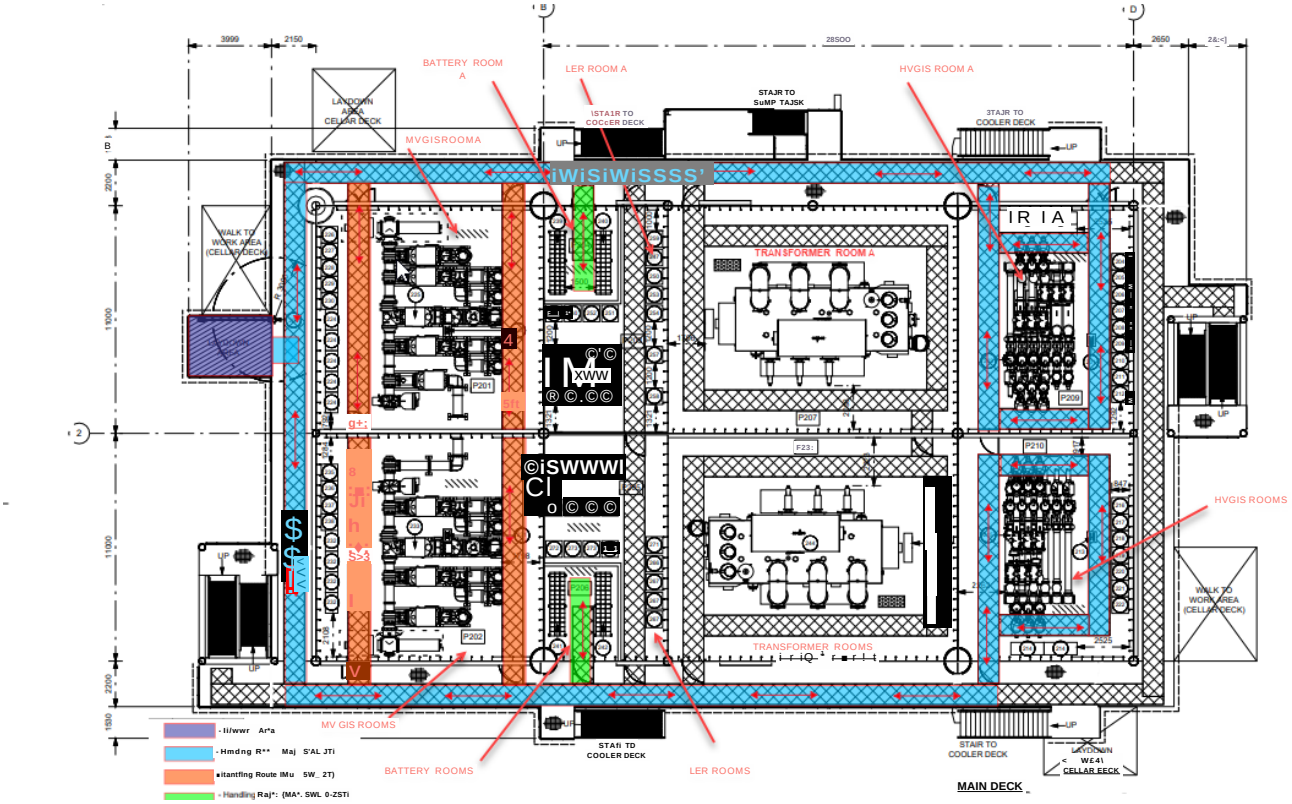


Figure 9. Example of room layout for indication only. The topmost is showing a utility deck and the bottommost is showing a main deck deck

12.2 Architectural

The outside walls shall be insulated except for the high heat generating major equipment rooms housing transformers and reactors where they are un-insulated to aid equipment cooling.

Doors, window frames and hatches shall be maintenance free. Doors shall be approved by Company. Material selection shall be approved by Company. All doors shall have fire rating according to the fire rating of the wall, exterial doors shall have rain gutters. Doors shall be supplied with door pumps or end stops.

All doors leading into rooms containing HV and MV equipment shall be provided with a vision panel.

The vision panels shall be an integral part of the certified door. The glazed area shall be approximately 200 mm x 500 mm (width x height) or 400 mm x 400 mm (width x height), and consist of tempered security glass.

Doors to high voltage rooms (rooms containing high voltage equipment) shall open out from the room.

All external doors shall be provided with “panic opening device” which may be opened without using hands, and also from a "crawling at the floor" position. Internal doors shall open in direction of the documented escape path. Where the escape path is “both ways”, the door may be opened both ways.

Door dimensions shall be in accordance with the material handling needs and requirements for the individual rooms.

Hinged doors leading to open areas and located such that they could be exposed to rough weather and wind, shall be provided with damping mechanism to prevent crushing injuries or with mechanically assisted opening of doors.

The opening force of doors (i.e. the initial force required to open a door) as measured with a dynamometer or similar device, shall not exceed 65N for hinged doors and 50N for sliding doors. Deviations from this shall be agreed with company.

All rooms shall have space for and equipped with a foldable table, appropriately secured and fastened when not in use.

Access from boat landing(s) to the OSS shall be surrounded with a mesh cage and a lockable entrance door to prevent intrusion. This “mariner cage” can be pre-fabricated and installed after topside hook-up to not obstruct cable during submarine cable handling. The lock design on entrance door must facilitate escape from platform even if locked. On the boat landing side of the mariner cage(s) there shall be two-way communication facility to onshore CCR. The mariner cage shall have alarm indication gate open/closed and gate unlocked. The open/closed position shall be viewed in the SCADA HMI screen picture. Fixed camera outside looking into the Mariner Cage shall be installed for detection of any intruders and to see persons in an emergency/rescue situation. The camera should be able see in the dark with use of IR or thermal cameras.

Multipurpose area shall have 3mm vinyl floor covering.

All required thresholds shall be dimensionally as low as possible, without impairing function with regard to fire rating, noise reduction and ability to stop ingress of water
Appropriate ramps for material handling shall be provided where needed. If removable ramps they shall be stored in the vicinty of the door.

Plaform Colour Schedule shall be furhter developed from document in Appendix E

12.3 Door Locking system

All doors, internal and external, shall be fitted with a suitable and recognized cylinder-type lock specified by company.

For outer door entrances:

- Main entrance to the multi-purpose area shall be equipped with a keypad. The keypad shall be used for initiating or deactivating the alarm in the multi-purpose area. Disconnection of the alarm shall also be possible from CCR.
- Doors shall be equipped with key lock for entering as defined as described:
    - The multi-purpose area is preferred open, without a lock (given that there is no HMI with control in the multi-purpose area.
    - SCADA room, diesel generator container, control and protection room, HVAC room and future panel room to be counted as LV-rooms and locked accordingly
    - Fire room to remain unlocked
- All external doors shall be equipped with door open/closed door contacts with position viewed on the HMI screen
- Alarm signal to ESI SCADA for door open and not closed within a certain time shall be included

- Area/room inside shall be equipped with PIR motion detectors

Key hierarchy shall be as follows:

1. HV operational key (opens HV, LV and general access, and also opens operational padlocks)
2. HV access key (opens HV, LV and general access)
3. LV access key (opens LV and general access)
4. General access key
5. Separate key for metering rooms

12.4 Storage

The following functions and capacities shall be included for in the design

- Storage space for required safety and emergency equipment according to 3.3.1.
- Storage space for required rescue equipment
- Filing cabinets for facility documentation and work permit system, located in same area as the SCADA/engineering workstations
- A combined platform storage and workshop area to be provided, with shelves, work bench, suitable number of sockets for tools and charging of battery-powered tools. With minimum size 15 m^2 (Approx. one 20-foot container). The storage door width shall accommodate material handling with a trolley.

13 Topside structure

13.1 General

For applicable design codes and standards, please refer to Appendix E of the Contract. The load-bearing structure shall comply with all limit states (ULS, SLS, ALS and FLS) in all temporary and permanent phases as defined by the govering standards, i.e. during construction, weighing, Load-Out, transportation, installation and operation. Local damage or failure shall not entail loss of human life, significant pollution or major financial consequence.

The following requirements shall apply for topside structural design:

- Structures and structural elements shall be designed with ductile resistance behavior.
- A joint in a main structure truss framework shall have a capacity equal to or exceeding the load bearing capacity of any adjoining member.
- A structural truss framework shall aim for a design with few joints and members with simple and predictable load path.
- Structures shall be designed to minimize eccentricities and stress concentrations and provide a well-defined stress path.
- The design shall ensure that fabrication, including surface treatment, can be accomplished in accordance with relevant recognized techniques and practices.

- The design of details, selection of profiles and use of materials shall be done with the objective to minimize corrosion, degradation, and the need for special precautions to prevent corrosion and degradation.
- Adequate access for inspection, surveillance, maintenance and repair shall be provided.
- Primary members subject to axial tension loads or fatigue loads shall transfer the load by shear connections or by full penetration butt welds.

For design and fabrication, it is recommended to follow standards for design, manufacturing/fabrication which the suppliers and sub-suppliers are familiar with. Contractors preferred standards shall be agreed and accepted by Company.

The offshore substation shall be designed for all relevant loads with load combinations and load factors according to DNV-ST-0145 Offshore Substations /2/.

13.2 Fatigue

Fatigue design of the substation topside shall be in accordance with DNV-ST-0145 Offshore substations /2/ and DNV-RP-C203 Fatigue design of offshore steel structures /6/.

Fatigue damage due to transportation and other relevant temporary phases shall be calculated and combined with fatigue damage from in-place.

Improvement of fatigue life by changing the geometry and not by weld improvement techniques such as grinding, hammer peening etc. Fatigue friendly design shall be focused on in order to prevent redesign and costly reconstruction.

Fatigue sensitive areas in primary structure shall be communicated to other disciplines as no-go areas, i.e. no attachments or penetrations in these areas.

Fatigue sensitive structural elements shall be provided with access for inspection where practically possible. Structural details which are covered by permanent spray-on fire protection (PFP) shall be considered as not accessible for inspection, unless access is provided from inside or backside

The number of load cycles shall be multiplied with the appropriate factor in the table 5. below before fatigue analysis is performed.

Table 5. Design Fatigue Factor (DFF)

Classification of structural components based on damage consequence	**Not accessible for inspection and repair**	**Accessible for Inspection, maintenance and repair, and where inspections or maintenance is planned.**
Substantial consequences	10	2
Without substantial consequences	3	1

1. "Substantial consequences" in this context means that failure of the joint will entail
   a) danger for loss of human life
   b) significant pollution
   c) major financial consequences
2. "Without substantial consequences" is understood as failure where it can be demonstrated that the structure satisfies the requirement to damaged condition according to the ALSs with failure in the actual joint as the defined damage.

13.3 Robustness and redundancy

A robust primary structure with structural redundancy shall be developed. Robustness is the property of a structure that enables it to survive unforeseen, unexpected or unusual circumstances. Robust in this context also implies that a joint shall not fail before an adjoining member. This provides a damage tolerant structure with ability to re-distribute forces.

Structural redundancy implies that failure of one member shall not lead to progressive collapse. The redundancy criterion shall be based on ALS principles and on realistic scenarios for damage or failure.

13.4 Design of structures

Installation aid structures that are planned to be removed shall be designed taking methods for safe and easy removal into account. For fatigue sensitive areas, temporary welded structures should be avoided, if required they need to be removed, ground flush and inspected by NDT.

Fatigue sensitive areas in primary structure shall be communicated to other disciplines. Attachments or penetrations in these areas shall be avoided as far as possible. Drawings presenting "no-go-areas" for attachment welds or penetrations shall be established to ensure compliance with prerequisites from designer.

Deck plate on top of H/I girders/profiles is not acceptable. Deck plates shall be flush top of steel with top flange of H/I-girders/profiles. Deck plates with thickness below 8 mm should not be used.

All welds shall be full penetration where normal stresses transverse to the weld are dominant.

Use of bolted joints in permanent structural connections shall be limited to a minimum unless otherwise required to ensure functionality (e.g. need to shim, replace component etc.). As base case structural connections of permanent character shall be made as welded connections.

13.4.1 Design of laydown area

Laydown areas shall be provided with barriers that can absorb the energy induced by the loads that are planned handled at the lay down area without loss of functionality.

13.4.2 Requirements to grating

Load bearing capacity for grating panels shall be documented for loads. Point actions may be distributed on an area of 300x300mm. Project specific requirements may apply in addition.

Steel surfaces coated by painting or PFP that support grating shall be protected with non-metallic pads.

Material in gratings shall be subject to evaluation. Experience show that late changes and modifications will occur in construction phase of a project, which is very costly when using galvanized steel grating. As a result of this also stainless steel grating should be evaluated and recommendation presented to Company.

13.4.3 Requirements to bolted connections

Structural bolts, washers and nuts shall be in accordance with NORSOK M-101.

13.5 Global computer model and analyses

Structural analyses shall be performed using a well-recognized and documented software suitable for the required analysis. Software selection shall be described in the Design Brief and agreed with Company.

The static system and distribution of forces and moments in the structure shall be verified. Computer-plots shall be presented for selected load cases/design conditions, and shall be subject to quality control, in order to check correctness of load application and demonstrate expected structural behavior/response.

13.6 Airgap

For airgap reference is given to C256-EQ-Z-SP-00012, OSS Substructure Technical Specification, MFW and MFW /4/.

Wave impact

If there are structures protruding from underneath the topside that cannot have positive airgap, they shall in addition be designed for local impact loads due to breaking waves for (ULS) 100- year return period and (ALS) 10 000-year return period storm conditions. Both vertical and horizontal impact loads shall be included as applicable.

13.7 Ship impact

In case of a ship collision, ref. /4/, collision with vessel superstructure shall be considered in design of the topside. Critical equipment or equipment that cause environmental harm in case of a collision shall not be positioned in an area where it can be exposed to ship impact.

13.8 Boat landings for CTV

. Reference is made to /4/.

14 Material selection

Material Selection and corrosion protection design shall be performed in accordance with the materials selection philosophy, /7/. This is applicable to, and not limited to, all equipment to be installed on the OSS, structures and bulk items.

15 Marine operations

15.1 Transport & installation

Strength, deflections and fatigue of topside structure, equipment and supports during transportation and installation shall be evaluated and taken into consideration in design.

Deflections of topside structure shall be taken into consideration in transport and installation analyses.

The transportation of topside shall be designed for an un-restricted tow in accordance with applicable codes in Appendix E.

Marine operations shall be in accordance with “Marine operations and marine warranty” DNV-ST-N001 /19/. If DNV-ST-N001 is unclear, the VMO Standard /5/ shall be used as guidance and for clarity.

If during transportation, the top of the topside is the highest point, aircraft warning lights shall be fitted to the highest point on the topside.

Temporary navigation aids, such as obstruction lights and radar reflectors, shall be fitted to the topside.

In general, transport operations shall be designed as weather unrestricted operation. For transport by HTV with a vessel speed higher than 12 knots, weather restricted operation may be considered.

See also requirements to fatigue calculation during transport in chapter 13.2.

16 Installation and replacement of Offshore Export Cables

The OSS topside shall be designed to facilitate for installation of a temporary pull-in system for the offshore export cables (2 off). The design must consider temporary storage and final routing of the 3 power conductors from hang-off to the final connection point GIS. The OSS cable routing must be designed to ensure Minimum Bending Radius (MBR) and required pull-in lengths and manipulation of both cables to respective termination points.

The OSS topside shall be designed to minimize required re-grips, preferably require one grip to pull in required overlength. The pull-in shall be performed in as straight line as possible and shall facilitate safe and efficient stripping and untwisting of the cable conductors.

The final cable routing of each EC (3 conductors) shall include e.g. snaking to allow for re-termination in case of termination failure at GIS. If failure happens along between the hang-off and termination a in-line repair joint will be installed, the final cable routing of EC shall facilitate for the installation of in-line repair joint

The OSS topside design must take into account pull-in forces for the Offshore Export cables of 25-30 Te (measured above the j-tubes)

The OSS design must take into account that the temporary pull-in system might include, but is not limited to:

- Winch(es)
- Winch foundation
- Winch associated ancillaries and outfitting
- All necessary sheaves and wire routing system to allow for cable pull-in from each respective j-tube end position at the cable deck
- All cable routing design
- Structural strong points, anchor points and other permanent and temporary structures on the OSS required for the pull-in system
- All temporary and permanent cable support arrangements such as cable ladders/scaffolding/support structures

All required cable trays and supports shall be designed and included to take into account all phases of the cable installation.

The design shall accommodate replacement of the submarine cables after installation.

The OSS topside shall have sufficient space for all commissioning / MC activities, including pull-in and connection of cables and fibres shall be accommodated. Space for manipulating, routing, stripping and untwisting submarine cables and shall be taken into account.

The design shall take into account all permanent and temporary structures and outfitting required to facilitate Offshore Export Cable pull-in and installation activities. This includes fall prevention systems, sea fastening, storage space, laydown space and similar.

The cable pull-in and termination study shall document design and layout accommodating safe and efficient handling of the Offshore Export cables considering the different scenarios with/without topside present, all/portion of the cables present and confirm correct tools and ancillaries are included.

The cable deck is described in C256-EQ-Z-SP-00012, OSS Substructure Technical Specification, MWF and MWF /4/.

17 Installation and replacement of Inter Array Cables (IAC)

The OSS topside shall be designed to facilitate for installation of a temporary pull-in system for the inter array cables (10 off). The design must consider temporary storage and final routing of the 3 power conductors from hang-off to the final connection point (Pluggable Joint). The OSS cable routing must be designed to ensure Minimum Bending Radius (MBR) and required pull-in lengths and manipulation of both cables to respective termination points. Final cable routing shall be based on a minimum of 1.5x of the minimum bending radius of the individual single core cable, given that it is not practical to route and install single core cables in the final configuration at their minimum bending radius.

The OSS topside shall be designed to minimize required re-grips, preferably require one grip to pull in required overlength. The pull-in shall be performed in as straight line as possible and shall facilitate safe and efficient stripping and untwisting of the cable conductors.

The OSS topside design with large and suitable number of pad eyes (to be confirmed by IAC Contactor) shall be available below all decks and above the J Tube to allow for temporary hold backs and other operations during cable installation.

The OSS design must take into account that the temporary pull-in system might include, but is not limited to:

- Winch(es)
- Winch foundation
- Winch associated ancillaries and outfitting
- All necessary sheaves and wire routing system to allow for cable pull-in from each respective j-tube end position at the cable deck
- All cable routing design
- Structural strong points, anchor points and other permanent and temporary structures on the OSS required for the pull-in system
- All temporary and permanent cable support arrangements such as cable ladders/scaffolding/support structures

All required cable trays and supports shall be designed and included to take into account all phases of the cable installation.

The design shall accommodate replacement of the submarine cables after installation if required.

The OSS topside shall have sufficient space for all commissioning/MC activities, including pull-in and connection of cables and fibres shall be accommodated. Space for manipulating, routing, stripping and untwisting submarine cables and shall be taken into account.

The design shall take into account all permanent and temporary structures and outfitting required to facilitate Inter Array Cable pull-in and installation activities. This includes fall prevention systems, sea fastening, storage space, laydown space and similar.

The cable pull-in and termination study shall document design and layout accommodating safe and efficient handling of the inter array cables considering the different scenarios with/without topside present, all/portion of the cables present and confirm correct tools and ancillaries are included.

The cable deck is described in C256-EQ-Z-SP-00012, OSS Substructure Technical Specification, MWF and MWF /4/.

18 Abbreviations

AC	Alternating Current
AIS	Automatic Identification System
ALS	Accidental Limit State
ALARP	As Low as Reasonably Practicable
BII	MWF
BIII	MWF
CCR	Central Control Room
CCTV	Closed Circuit Television
CT	Current Transformer
CTV	Crew Transfer Vessel
ConEd	Consolidated Edison
C&P	Control & Protection
DC	Direct Current
DFF	Design factor fatigue
DG	Diesel Generator
EER	Escape, Evacuation and Rescue
EC	Export Cable
EMC	Electromagnetic Compatibility
EMF	Electromagnetic Field
EOA	Emergency Overnight Accommodations
EPC	Engineering, Procurement and Construction
ESI	Electrical System Infrastructure
FCU	Fan Coil Unit
FiDe	Fire Detection
FiFi	Fire Fighting
FMECA	Failure mode, effects, and criticality analysis
FRT	Fault Ride Through
FAT	Factory Acceptance Test
GIS	Gas Insulated Switchgear
GCP	Generator Control Panel
GWP	Global Warming Potential
HAT	Highest Astronomical Tide
Hs	Significant Wave Height
HSE	Health, Safety and Environment
HMI	Human Machine Interface
HTV	Heavy Transport Vessel
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
IAC	Inter Array Cable
ITP	Inspection and Test Plan
IE	Instrument Earthing
IEDs	Intelligent Electronic Devices
IGIS	Intelligent Gas Information System
IMS	Information Management System

JUR	Jack-up rig
LED	Light Emitting Diode
LV	Low Voltage
MBR	Minimum bending radius
MCB	Miniature Circuit Breaker
MCC	Motor Control Center
MEWP	Mobile Elevated Work Platform
ONS	Onshore Substation
OSS	Offshore Substation
O&M	Operation and Maintenance
PASMA	Prefabricated Access Suppliers' & Manufacturers' Association
PDCS	Power Distrubution Control System
GA	General alarm
PAS	Platform Automation System, see SUS.
PE	Protective Earth
PFP	Passive Fire Protection
Ph	Phase
P&ID	Piping and Instrument Diagram
POB	Personnel on Board
POI	Point of Interconnection
RCD	Residual Current Device
RAM	Reliability, Availability and Maintainability
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SIL	Safety Integrity Level
SOV	Service Operation Vessel
SSU	Safety, Security and Sustainability
SUS	Safety and Utility System
SWL	Safe Working Load
TDR	Time-domain Reflectometer
TSO	Transmission System Operator
UAV	Unmanned Aerial Vehicle
ULS	Ultimate Limit State
UPS	Uninterruptible Power Supply
VRLA	Valve-Regulated Lead Acid (battery)
VSD	Variable Speed Drive
VT	Voltage Transformer
WTG	Wind Turbine Generator
WPP	Wind Power Plant
W2W	Walk-to-Work

19 References

/1/ PM735-PMS-050-001 MFW and MFW Design Basis revision 2

/2/ DNV-ST-0145, Offshore Substations

/3/ C274-EQ-Z-SP-00001, Metocean Design Basis and C275-EQ-Z-SP-00001 Metocean Design Basis C256-EQ-Z-SP-00012, Offshore Substation (OSS) Substructure Technical Specification MFW & MFW

/4/ "VMO Standard" - DNV offshore standards covering marine operation, DNV-OS-H101, DNV-OS-H102 and DNV-OS-H201 through DNV-OS-H206

/5/ DNV-RP-C203 Fatigue design of offshore steel structures, C256-EQ-M-FD-00001 Materials Selection Philosophy &III

/6/ TR3023 Electrical, instrument and telecommunication installations, offshore units

/7/ TR4031 Automation Technology - Offshore wind

/8/ C256-EQ-T-SP-00001 Telecommunication Technical and Functional Requirements

/9/ ISO 14122:2016, part 1-4

/10/ C256-EQ-R-SP-00001, Offshore Cranes Design and Functional Requirements

/11/ TR3026 Electrical System Design Offshore Wind

/12/ IEC618

/13/

/14/

/15/ TR0926 Working environment

/16/ TR1668 Prohibited and Restricted Chemicals

/17/ C256-EQ-S-FD-00003 Safety Strategy for offshore substations MFW and MFW ISO 19902 -

/18/ Petroleum and natural gas industries Fixed steel offshore structure

/19/ DNV-ST-N001; Marine operations and marine warranty

/20/ PM735-PMS-094-001 MFW Operations and Maintenance Requirements Offshore Wind Project C256-EQ-J-SP-00002 Automation Technical and Functional requirements

/21/ C256-EQ-J-SP-00006 Cyber Security Design Requirements

/22/ C256-EQ-J-XI-00001-01 Automation/IACS Network Topopology drawing

/23/ C274-RA-E-FD-01000 Design Brief – Electrical Low Voltage System

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