**Non-Binding Indicative Proposal**

**for**

**Anma-do 224MW Offshore Wind Farm Project**

**(Phase 1)**

* **Technical Proposal -**

**Jan, 2022**

HEC CI

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Chapter 1. Background of the Project

## Introduction

We, Hyundai Engineering Co., Ltd., (hereinafter called ‘HEC’) intend to provide the indicative proposal to Anma Offshore Wind Energy Co., Ltd. (hereinafter called ‘AWC’ or ‘SPC’) of a wind power project with a total generation capacity of 224MW capacity. This Proposal is prepared only on an indicative EPC cost basis in order to undertake the Engineering, Procurement, Construction and Commissioning. This is made based on the outcome of Concept design for Phase 1 which is performed by HEC with ARUP. HEC will constitute a consortium with wind turbine generator manufacture as partner and the leader of this consortium will be HEC.

## Basic Project Information

1. Project name : Anma-do 224MW Offshore Wind Farm Project
2. Location : 5km from Anma Island, Yeonggwang-gun, Jeollanam-do
3. Grid Connection : Site ↔ Anmado S/S 5km(Approx.)

Anmado ↔ Younggwang #2 S/S 45km(Approx.)

1. Project configuration cases

* Case 1. WTGs (Doosan 8MW, 28ea), Substructure (3 legs Jacket type), Cable, On-shore substation and all relevant BOP facilities
* Case 2. WTGs (SGRE 10MW, 23ea), Substructure(3 legs Jacket type), Cable, On-shore substation and all relevant BOP facilities

1. Capacity : 224MW(Doosan 8MW) & 230MW(SGRE 10MW)
2. Water level : 16~27m D.L(Datum Level)
3. Wind condition : 7.32m/s at 130m above M.S.L
4. Environment : 90km from Mokpo port and Low possibility of earthquake

Some design parameters that are not accurate have been assumed to estimate the indicative cost and performance.

Chapter 2. Scope of Works

## Scope of Works

This proposal will cover the following activities as specified in this section for the proposed off-shore Wind Farm Project on EPC turnkey basis:

* Project and Construction Management
* Engineering and Design
* Equipment Supply and Transportation
* Construction and Erection
* Start-up and Commissioning
* Performance Test
* Site Supervision and Advisory Service

The further discussions are necessary during project negotiation stage before entering into Contract in order to define all the details of each activity and get rid of any gray areas.

## Scope of supply

Major scope of works for this indicative proposal is defined in the following table;

| **NO** |  | **Case 1. Doosan 8MW** | | **Case 2. SGRE 10MW** | | |
| --- | --- | --- | --- | --- | --- | --- |
| **1.0** | **WIND TURBINE GENERATOR** | DS205-8MW | 28 sets | SG DD 200–10MW | 23 sets | |
| 1.1 | Nacelles, Direct drive generator, Hubs, Blades (3 blade per 1 set) with associated mechanical system | | | | | |
| 1.2 | Towers and associated internal structures | | | | | |
| 1.3 | Electrical, Control and Communication systems including SCADA and other interfaces | | | | | |
| 1.4 | Equipment and accessories for erection and commissioning | | | | | |
| 1.5 | Fire protection system | | | | | |
| 1.6 | HVAC System | | | | | |
| 1.7 | Miscellaneous | | | | | |
|  | | | | | | |
| **2.0** | **ELECTRICAL EQUIPMENT** | | | | | |
| 2.1 | Substation (Juk-do island) | | | | | 1 Lot |
| 2.2 | Switching station (Yeonggwang-gun) | | | | | 1 Lot |
| 2.3 | Offshore cable (Submersible, Array & Export) | | | | | 1 Lot |
| 2.4 | Onshore cable (U/G, Export) | | | | | 1 Lot |
| 2.5 | O/H Transmission (Songyi-do island) | | | | | 1 Lot |
|  | | | | | | |
| **3.0** | **PLANT CONTROL SYSTEM** | | | | | |
| 3.1 | Turbine control system (provided by Turbine Supplier) | | | | | 1 lot |
|  | | | | | | |
| **4.0** | **CIVIL WORKS** | | | | | |
| 4.1 | Topographical surveys and Topographical reports for the onshore site area | | | | | 1 lot |
| 4.2 | Jacket works for substructure and piles | | | | | 1 lot |
| 4.3 | Site preparation for substation (Juk-do island) | | | | | 1 lot |
| 4.4 | High voltage cable line work (Juk-do island) | | | | | 1 lot |
| 4.5 | Site preparation for switching station & monitoring house at onshore area | | | | | 1 lot |
| 4.6 | High voltage cable line work at onshore area (Yeonggwang-gun) | | | | | 1 lot |
| 4.7 | Soil improvement and Pile works for onshore structure | | | | | 1 lot |
| 4.8 | Road and Paving | | | | | 1 lot |
| 4.9 | Fence and Gate | | | | | 1 lot |
| 4.10 | Storm drainage system | | | | | 1 lot |
|  | | | | | | |
| **5.0** | **BULIDING WORKS** | | | | | |
| 5.1 | 154kV/66kV GIS building (Juk-do island) | | | | | 1 lot |
| 5.2 | Monitoring & GIS control building (Juk-do island) | | | | | 1 lot |
| 5.3 | 154kV Switching station (Yeonggwang-gun) | | | | | 1 lot |
| 5.4 | Monitoring house (Yeonggwang-gun) | | | | | 1 lot |
| 5.5 | Warehouse (Juk-do Island) | | | | | 1 lot |
| 5.6 | Warehouse (Yeonggwang-gun) | | | | | 1 lot |

## Exclusion of Works

The following equipment and services are excluded from EPC Contractor’s extent of works and to be provided by the SPC, or other contractors

* Land acquisition, easements and authorization (on/off shore area)
* Land acquisition for transmission line
* Geotechnical surveys including site tests, sampling, soil report, geological report
* Bathymetric surveys and report for offshore area
* Scouring protection for offshore jacket structure
* Consumables and lubricants after mechanical completion
* Operating personnel for commissioning, performance test and reliability runs after mechanical completion
* Two (2) years spare parts, strategic and recommended spare parts
* Shop training
* EIA (Environmental Impact Assessment) works
* All permits, consents, licenses which are not related to EPC execution
* Workshop & Laboratory equipment
* Office furniture (except for control room furniture) and electronic appliance
* All equipment, system or service which are not expressively mentioned in this proposal

Chapter 3. Technical Description and Assumptions

This chapter delineates the technical description and assumptions made to prepare the indicative proposal. This proposal is based upon these assumptions and they will prevail during the engineering of this project unless modified by Contract requirement as further design period

## Wind Turbine Generator

## DS205-8MW (DOOSAN 8MW)

**Operating Data**

|  |  |
| --- | --- |
| Type Class | TC 1B |
| Hub height | 130 m, Site specific |
| System life | 25 years |
| Cut-in wind speed | 3.0 m/s |
| Rated wind speed | 10.0 m/s |
| Soft cut-out starting wind speed | 25.0 m/s |
| Cut-out wind speed | 30.0 m/s |
| Survival wind speed | 50.0 m/s (10 min average),  70.0 m/s (3 sec average) |

**Rotor**

The wind turbine, DS205-8MW has a three-bladed upwind rotor. Its rotational speed is limited by blade pitch control. The advantage of pitch control lies in the lower peak loads at high wind speeds. The wind energy conversion system is subject to substantially lower dynamic loads, especially at sites with high turbulence intensity. The rotor offers high operational reliability and longer service life with minimal maintenance effort due to its enhanced pitch-control system.

**Pitch system**

The blades can be turned out of the rotor plane by about 90 degrees and therefore act as aerodynamic brakes. During normal operation, the pitch motors hold the rotor blades in a defined position via the ring gear (pitch bearing) mounted to the blade root. The aerodynamic brake is applied by varying the rotor blade pitch by means of motors. In the event of a fault (e.g. grid loss), the pitch motor is powered by a battery system, so can still control the pitch. Consequently, DS205-8MW incorporates a "fail safe" design. For example, if one pitch drive cannot be activated (e.g. broken cable, broken power supply to hub), the other two blades can still be turned into feathering position. Therefore, DS205-8MW is automatically stopped at any time, even without any power supply to the hub.

**Rotor hub**

The cast iron rotor hub is attached in front of main shaft. The three pitch systems are easily to be maintained as they are mounted within the hub alongside the blade root flanges. cooling fans are equipped to extract heat from hub inside.

**Main bearing unit (MBU)**

Rotor and Generator are connected with main bearing unit (MBU), which is comprised of static inner shaft, rotational outer shaft and two main bearings. Inner shaft & outer shaft are main structure of MBU which are made of cast iron material. Between them, two TRBs (tapered roller bearing) are assembled to transfer the load from the hub. Outer shaft is connected between hub and generator, otherwise, inner shaft is connected to mainframe of nacelle to support MBU. A rotor lock at the stator of generator enables the drive train to be mechanically locked for maintenance purposes.

**Generator and Power Electronics**

The type of generator is direct drive without gearbox and permanent magnet synchronous generator. The advanced full-scale power electronics (IGBT converter) ensures that the generator works with high efficiency over the entire speed range. In addition, there are sensors to monitor the temperature in the generator. The generator and the power electronics are cooled by a water­air heat exchanger.

**Transformer**

To adjust 690V voltage from generator to substation, oil-immersed transformer installed in the nacelle. High voltage side can be supplied according to site specific as 22.9kV, 33kV and 66kV. Auxiliary transformer is installed to provide the power to inner components.

**Mechanical brake**

The mechanical brake is a disc brake fitted with 8 calipers and mounted in front of the shaft. The hydraulic system is pressurized. To activate the brake, solenoid valves are activated, and the brake pads are pressed against the disc. An intelligent braking system controls the braking sequence. The brake can be activated by discharging the hydraulic circuit.

**Nacelle support structures (Mainframe, Support frame, Bed plate)**

The cast iron mainframe is main support structure and transfers the loads from hub to the tower. It supports not only generator but also almost nacelle components with support frame and bed plate. Bed plate is attached to the rear side of mainframe and it supports nacelle components. The support frame which is a steel frame is also connected to the mainframe and it supports nacelle cover.

**Yaw system**

The yaw system consists of an outer ring gear which is bolted to the mainframe, plus a slew bearing. The yaw system is driven by ten converter-fed electrical motors with a gearbox and a pinion mounted onto the base plate of the main frame. Additional yaw brakes keep fixed position until it needs to be realigned with the actual wind direction. The brakes are released when the nacelle is turned. The yaw actuators also keep the nacelle in a fixed position, even at high eccentric wind loads.

**Control system**

The control system is based on an industrial type PLC system. It is in special cabinets, mounted in the hub, nacelle and tower base. The status of DS205-8MW can be monitored and is controlled by the control system.

**Tower**

DS205-8MW features a conical tubular steel tower with internally screwed top flange for high maintenance safety. Inside the tower, there is a lift and a ladder for accessing the nacelle. The ladder is equipped with a climbing protection system to prevent maintenance staff from falling. The tower is equipped with working and emergency lightning, and contains working platforms at the flange connections, and resting platforms in each tower section.

## SG DD-200 (SGRE 10MW)

**Operating Data**

|  |  |
| --- | --- |
| Type Class | TC S (1B) |
| Hub height | 135 m, Site specific |
| System life | 25 years |
| Cut-in wind speed | 3.0 ~ 5.0 m/s |
| Rated wind speed | Approx. 12.0 ~ 14.0 m/s |
| Soft cut-out starting wind speed | - |
| Cut-out wind speed | 28.0 m/s |
| Survival wind speed | 70.0 m/s (3 sec average) |

**Rotor**

The SG DD-200 rotor is a three-bladed cantilevered construction, mounted upwind of the tower. The power output is controlled by pitch regulation. The rotor speed is variable and is designed to maximize the aerodynamic efficiency.

**Blades**

The blades are made of fiberglass-reinforced epoxy and carbon fiber-reinforced epoxy. The blade is manufactured using the Siemens Gamesa proprietary lntegralBlade® manufacturing process. In this process the blades are cast in one piece to eliminate weaker areas at glue joints. The blades are mounted on pitch bearings and can be feathered for shutdown purposes. Each blade has its own independent pitching mechanism capable of feathering the blade under any operating condition. The blade pitch arrangement allows for optimization of the power output throughout the operating range, and the blades are feathered during standstill to minimize wind loads.

**Rotor Hub**

The rotor hub is cast in nodular cast iron and is fitted to the generator rotor with a flange connection. The hub provides a comfortable working environment for service technicians during maintenance of blade roots and pitch bearings.

**Main Shaft**

A cast, hollow and fixed main shaft ensures a comfortable internal access from the canopy to the hub.

**Main Bearing**

The rotating parts of the wind turbine are supported by a single bearing. The bearing is a double row tapered roller bearing. The bearing is lubricated by an automatic lubrication system.

**Generator**

The generator is a fully enclosed synchronous generator with permanent magnet excitation. The generator rotor construction and stator windings are designed for high efficiency at partial loads. The generator is positioned between the tower and the hub producing a comfortably lean arrangement of the internals in the nacelle.

**Mechanical Brake**

The mechanical brake is fitted to the generator and has hydraulic calipers.

**Yaw System**

A cast bed frame connects the shaft to the tower. The yaw bearing is an externally geared ring with a friction bearing. A series of electric planetary gear motors drives the yawing.

**Canopy**

The weather screen and housing around the machinery in the nacelle is made of glassfiber-reinforced plastic panels.

**Tower**

The SG 00-200 wind turbine is mounted on a tapered tubular steel tower. The tower has internal ascent and direct access to the yaw system and nacelle. It is equipped with platforms and internal electric lighting.

**Controller**

The wind turbine controller is a microprocessor-based industrial controller. The controller is complete with switchgear and protection devices. It is self-diagnosing and has an interface for easy readout of status and for adjustment of settings.

**Converter**

The NetConverter® power conversion system allows generator operation at variable speed, frequency and voltage while supplying power at constant frequency and voltage to the MV transformer connected to the grid. The power conversion system is a modular arrangement for easy maintenance and is water cooled.

**SCADA**

The SG 00-200 wind turbine is equipped with the Siemens Gamesa SCAOA system. This system offers remote control and a variety of status views and useful reports. The status views present information including electrical and mechanical data, operation and fault status, meteorological data and grid station data.

**Turbine Condition Monitoring (Conditioning Monitoring System/ CMS)**

In addition to the Siemens Gamesa SCAOA system, the SG 00-200 wind turbine is equipped with the unique Siemens Gamesa TCM condition monitoring system. This system monitors the vibration level of the main bearing and compares the actual vibration spectra with a set of established reference spectra. Result review, detailed analysis and reprogramming can all be carried out.

**Operation Systems**

The wind turbine operates automatically. It is self-starting when the wind speed reaches an average about 3 to 5 m/s. The output increases approximately linearly with the wind speed until the wind speed reaches around 12-14 m/s. At this point, the power is regulated at rated power.

## Electrical system

## Substation(Juk-do island)

The substation utilizes a scheme of single bus with indoor GIS (Gas Insulated Switchgear) type. This complete set of substation comprise the following minimum equipment:

* 154kV Gas insulated switchgear Three (3) Bays
* 66kV Gas insulated switchgear Six (6) Bays
* 66/154kV, 360MVA Oil type transformer One (1) Set
* Control, Protection & Metering system One (1) Lot
* SCADA & Telecommunication One (1) Lot
* LV distribution for the substation building One (1) Lot
* DC&UPS system One (1) Lot

## Switching station (Yeonggwang-gun)

The complete set of Switching station comprise the follow minimum equipment:

* 154kV Gas insulated switchgear Three (3) Bays
* 154kV, 150Mvar Shunt reactor One (1) Set
* LV distribution for the building One (1) Set
* DC&UPS system One (1) Set
* One (1) Lot Control, Protection & Metering system
* One (1) Lot SCADA & Telecommunication

## Offshore cable (Submersible, Array & Export)

The submersible cables are 3 core XLPE insulated and optical fiber composite type. Cable sizes are determined based on the concept design result that 300 & 800sqmm for the array cables and 800sqmm for the export cable respectively.

All the cables and accessories are described as below.

* 66kV submersible type array cable 43,120 m
* 154kV submersible type export cable 90,200 m
* Cable sealing end & accessories One (1) Lot
* Cable transition joint box One (1) Lot
* CPS(Cable protection system) materials One (1) Lot

## Onshore cable (U/G, Export)

The 154kV EHV cables are 1 core XLPE insulated type. Cable size is determined based on the concept design result that 800sqmm for export cable. Cable routing considered basically direct buried with splicing manhole, but the concrete encasing shall be applied at the road crossing areas.

All the cables and accessories are described as below.

* 154kV EHV cable 38,322 m
* Fiber optic cable 6,387 m
* Cable sealing end & accessories One (1) Lot
* Cable splicing material One (1) Lot

## O/H Transmission (Songyi-do island)

The 154kV O/H transmission in island between substation and switching station shall comprise the follow minimum Equipment:

* 154kV Transmission tower Five (5) Set
* O/H ACSR cable and accessories One (1) Lot

## Control and Instrumentation

The control system and related instrumentation will be provided by turbine supplier. Operation and monitoring will be done with HMI (Human Machine Interface) and relevant equipment in respective monitoring house.

* Major Monitoring house in the site of the switching station (Yeonggwang-gun)
* Minor Monitoring house (Juk-do island)
* Mokpo New port will be utilized as construction port and O&M port

## Civil

## WTG Substructure and Foundation (offshore)

The number of substructure and foundation is 28 and 23 for Doosan and SGRE WTG, respectively. A set of WTG substructure and foundation consists of transition piece, jacket, appurtenance, and pile as follows.

* Transition Piece TP main and TP platform
* Jacket 3-Leg Pre-piling Jacket
* Appurtenance Boat landing, Ladder, J-Tube, Anode, Stab-in
* Three (3) piles Pin pile for pre-piling

## Monitoring Houses, Substation (Juk-do island) and Switching station (Yeonggwang-gun) (onshore)

Civil Works for monitoring houses, substation (Juk-do island) and switching station (Yeonggwang-gun) are as follows.

* Site preparation Juk-do and Yeonggwang-gun (soil improvement)
* Pile works Yeonggwang-gun only
* Concrete works FDN, EDB, Trench, Storm Ditch, etc.
* Drainage works Pipe, M/H, Pit, etc.
* Road & Paving works Concrete & Gravel pavement
* High voltage cable line work Demolition, earth work, HDD, etc.
* Fence & Gate Juk-do island and Yeonggwang-gun

## Building

## Concrete Structures

Concrete structures will be designed with ultimate strength design (USD) method in accordance with KDS. The following strengths of concrete will be used.

- All concrete for building structure : fc = 24 MPa (Cylindrical Strength, 28days)

- Lean concrete : fc = 18 MPa (Cylindrical Strength, 28days)

Reinforcement steel used will be high yield strength deformed bars 400 MPa conforming to KS D 3504 SD400 or equivalent.

## Steel Structures

Structural steel shapes and plates will be in accordance with KS D 3503, KS D 3515 or equivalent. Structural steel will be designed in accordance with LRFD. All steel work will be designed, manufactured and erected in accordance with KDS.

## Building List

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Building Name** | **Str. Type** | **Q'ty** | **Story** | **Size** | | | **Remark** |
| **W(m)** | **L(m)** | **H(m)** |
| 1 | 154kV/66kV GIS building  (Juk-do island) | RC | 1 | 1 | 42.0 | 30.0 | 10.0 |  |
| 2 | Monitoring & GIS control building  (Juk-do island) | RC | 1 | 1 | 14.0 | 27.0 | 3.5 |  |
| 3 | 154kV Switching station  (Yeonggwang-gun) | RC | 1 | 1 | 25.0 | 44.0 | 8.0 |  |
| 4 | Monitoring house  (Yeonggwang-gun) | RC | 1 | 1 | 27.0 | 27.0 | 3.5 |  |
| 5 | Warehouse  (Jukdo Island) | ST | 1 | 1 | 9.0 | 9.0 | 6.0 |  |
| 6 | Warehouse  (Yeonggwang-gun) | ST | 1 | 1 | 9.0 | 9.0 | 6.0 |  |

## Fire Fighting

The complete set of Fire Protection System.

* Fire protection system One (1) Lot
* Fire alarm & Detection system One (1) Lot

## HVAC

## System Description

This proposal covers the design, engineering, selection of materials, procurement, manufacture, testing & inspection, construction and commissioning of Heating, Ventilation and Air Conditioning (hereinafter referred to as HVAC) system to the related Facility plant buildings.

In order to get comfortable environment to the occupants in the plant as well as to contribute towards maintaining a long life and normal operating condition of the main equipment, adequate heating, ventilation and air conditioning system will be provided to buildings.

The equipment selected will be capable of providing the stated indoor design condition with the stated external design condition and all internal heat loads and fresh air quantities as below.

## Outside Design Condition

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Seasons | Dry Bulb  Temperature  (°C DB) | Relative  Humidity  (% RH) | Wet Bulb  Temperature  (°C WB) | Remarks |
| Summer | 31.8 | 63.4 | 26.0 |  |
| Winter | -6.6 | 70.0 | -7.8 |  |

## Indoor Design Condition

|  |  |  |  |
| --- | --- | --- | --- |
| Room Name | Cooling  (°C DB) | Heating  (°C DB) | Humidity  (%) |
| Office, | 25±2 | 22±1.5 | N.C |
| Elec. equipment room, Battery room | 25±2 | N.C | N.C |
| Non-occupied areas (Note 1) | Only Ventilation | | |

Note :

1. Non-occupied areas mean warehouse.

## System Description

The HVAC system will be designed for continuous operation under all prevailing climatic and ambient conditions.

Air conditioned area will belong to individual air conditioning system. Individual air conditioning system will be composed of multi type air conditioner (indoor unit) and air cooled air condensing unit (outdoor unit).

Ventilation shall be provided by means of fans.

Individual Air Conditioning System

Individual air conditioning system will cover relatively small load of air conditioning which is consisted of Indoor Unit and ACCU (Outdoor Unit).

Multi Type Air Conditioner will consist of indoor unit which will be composed with fans, air filters, DX-cooling coil, accessories and outdoor unit. Outdoor unit will be located in the outdoor area.

Mechanical Ventilation System

Mechanical ventilation system will be provided for removing internal heat or refreshing indoor air via outdoor air. Mechanical ventilation system will consist of exhaust fan.

Ventilation fans for warehouse will be installed on the roof and its will be selected based on heat dissipation from equipment inside building for maintaining indoor temperature.

All toilets and locker rooms will be ventilated by fans with transferred air from adjacent areas.

Outdoor Equipment

Outdoor equipment will be weather proof type.

## HVAC Control System

HVAC control panel is DDC type.

HVAC control panel will be applied as below buildings

- Monitoring & GIS Control Building (Juk-do island)

- Monitoring House (Yeonggwang-gun)

- 154kV/66 kV GIS Building (Juk-do island)

## 