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## EMPLOYER REQUIREMENTS

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SØNDERBORG FORSYNINGSSERVICE A/S

DESCRIPTION OF BILL OF QUANTITIES

**Geotechnical investigation, Lillebælt Syd Nearshore Wind Farm**

PROJECT NUMBER 23.0830.01



DOCUMENT NO. : 12

Prepared for

21 DECEMBER 2017

**SWECO DANMARK A/S**  
T&M - PORTS & GEOTECHNICS WEST

**Sønderborg Forsyningsservice A/S**

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## Change list

VER.	DATE	STATUS	REVIEWED	APPROVED
001	12/12 2017	FIRST VERSION	LAJ, PES	PES
002	21/12 2017	FINAL VERSION	LAJ	PES

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## **Specification**

### **Project:**

Lillebælt Syd Nearshore Wind Farm

### **Subject:**

Offshore Ground Investigation BOQ Description

### **Location:**

Inner Danish waters south of Fyn

### **Owner/Employer:**

Sønderborg Forsyningservice A/S

### **Engineer:**

The Engineer will act on behalf of the Employer to monitor and supervise the works in accordance with the contract. The Engineer will be appointed by the Employer.

### **Bill of Quantities:**

The description of Bill of Quantities (BOQ) refers to the Bill of Quantities, has been prepared in order to describe what the quantity in each task (A, B and C) as minimum covers. Together with the Geotechnical Investigations Specifications, doc. No. 11, it forms the collective Employer's requirement for the geotechnical investigations.

The price for each subtask shall be filled into the BOQ; Doc. No. 13.

The quantity stated at each item is a preliminary estimate of the expected quantity. Significant variations of the quantities may be expected due to the nature of soil investigations. The Contractor will be paid for the actual quantity carried out in accordance with instructions and agreement with the Engineer. The Preamble to the contract defines payment details together with the amendments and additions.

### **Deadline:**

Final Interpretive Report shall be handed over no later than end of May year 2018. Task A and B shall be completed in due time for preparation of the Interpretive Report.

## 1 Preamble Amendments and Additions

### 1.1 Quantities

The quantities stated in the Bill of Quantities are estimated only. The Contractor's rates shall be valid within the stated variations in quantities.

### 1.2 Prices

The prices and rates inserted in the Bill of Quantities shall be the fully inclusive value of the work described under the respective items including all necessary project management, labour, plant, materials, tests, weather precautions, weather standby for the works, temporary works, permits, insurances, except those for which provision is made under separate items in the Bill of Quantities, overhead charges and profit, harbour fees, and all other costs and expenses, which may be required in and for the execution of the work described, together with all general risks, liabilities, and obligations set forth or implied under the Contract. All prices in the Bill of Quantities shall be priced net of Value.

### 1.3 Coverage of prices

A price or rate should be inserted against each item in the Bill of Quantities, whether quantities are stated or not. Items against which no price is entered will be deemed to be covered by the other prices and rates in the Bill of Quantities and will not be measured or paid for separately, whether the stated quantity be increased or not. No new items are to be added to the Bill of Quantities except where the Contractor is specifically instructed to do so, nor are any alterations to the items permissible.

### 1.4 Costs Included

If the cost of any item is to be covered by other items the wording "included" shall be entered in the rate column, stating the items covering the cost.

### 1.5 Unit rate coverage

The unit rates quoted in the Bill of Quantities will be deemed to cover tolerances, waste, cutting to waste, and removal of all types of waste according to in force laws and regulations in Denmark, working round obstructions, and working any hours.

### 1.6 Other works

Activities not itemized in the Bill of Quantities, which in the opinion of the Contractor should be separately priced, shall be added and priced by the Contractor under "Other Works". Measuring principles shall be defined as well.

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### 1.7 Coverage of rates and prices entered against items

Unless otherwise stated in the Bill of Quantities, the rates and prices entered against the various items of the Bill of Quantities shall include executing such items in all locations in accordance with the Contract, and shall include all associated temporary works.

All references made to water depths refer to the level from Mean Sea Level to the surface of the seabed.

Depths of borings, drillings and tests are generally measured from sea bed down to the location below the sea bed.

### 1.8 Dimensions

Unless otherwise stated, all dimensions given in the item descriptions of the Bill of Quantities are in metres.

### 1.9 Other Contractor's risk

In addition to the below, the rates quoted in the Bill of Quantities are inclusive of the Contractor's acceptance of the following specific risks:

- Movement restrictions due to weather, tidal, wave and current conditions
- Changes in rates of production due to changes in ground conditions encountered.

## 2 Task A, Mobilisation/demobilisation (A1)

All mobilisation and demobilisation of specific equipment, vessels or any other resources which can be expected necessary for execution of the described tasks, are to be covered by the sum of the cost for item A1.01 to A1.03.

Mobilisation and demobilisation will not be subject to re-measuring (except as may be provided under the task), and payment will be made on the basis of work done, in accordance with schedules agreed during Contract negotiations or, in the absence of such schedules, as may be determined by the Employer, based on the principle that payment shall not exceed corresponding proportion of work performed.

The term "Mobilisation/demobilisation" is used in the Bill of Quantities to cover mobilisation at start of works as well as the later demobilisation at end of works.

### 2.1 Vessels and/or Jack-ups for borings at 5-25 m water depth (A1-1)

Vessels and/or Jack-ups for borings at 5-25 m water depth cover the mobilisation and demobilisation of suitable vessels and/or jack-ups for carrying out borings on water depth at 5-25 m. The vessels and/or jack-ups shall be suitable for transporting and as working platform for the equipment and personnel for carrying out borings. This item covers all sailing to first and from last investigation locations including on load and off load of equipment, personnel and Employer's representative.

The Contractor shall document that chosen Vessels and/or Jack-ups have sufficient capacity for execution of geotechnical investigation.

Variation in quantities: -100% +100%

### 2.2 Geotechnical equipment for borings (A1-02)

This item covers mobilisation and demobilisation of all geotechnical equipment for offshore geotechnical borings.

Mobilisation and demobilisation of offshore geotechnical equipment including calibration also covers the following as applicable:

- Soil boring rig and equipment including all necessary equipment for soil sampling as open sampler, piston samplers, shells and augers and casings.
- Core drilling equipment with liners and core catcher
- Re-Circulation-equipment for bore-mud and saltwater
- Suitable shear vane equipment as Danish types (V4, V5, V7,5, V9,2, HVA)
- Standard Penetration Tests (SPT)
- Intact samplers for 70 mm Shelby tubes
- Bags for collection of disturbed samples
- Calibration of equipment
- Transportation to and from survey vessels/jack-ups

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- Weather downtime during mobilisation/demobilisation
- Transport of samples to laboratory

Variation in quantities: -100% +100%

### 2.3 Facilities (A1-3)

Mobilisation/demobilisation of facilities both onshore and offshore covers also:

- Suitable conditions for 2 Employer's representatives on board during the whole campaign. This may include board and lodging.
- Personnel
- Transport to and from the site for Contractor and the Employer's representative
- Site offices
- Stores
- Special equipment
- Materials
- Radio and communication systems and internet
- Website for online communication between vessel and onshore
- Laboratory
- Positioning systems DGPS
- Computers and software

Variation in quantities: -100% +100%

## 3 Task A, Boring at water depths 5-25 m (A2)

All resources for the execution of borings at water depths of 5-25 m, shall be covered by the sum of the cost for item A2.01 to A2.10. The sum of item A2.01 to A2.10 shall be reported at line A2 Boring at water depths 5-25 m under the column "Total cost".

### 3.1 Relocation of survey vessel/jack-up and positioning (A2-1)

Relocation of survey vessel/jack-up for geotechnical borings at water depths of 5-25 m. from one wind turbine location to another wind turbine location covers also

- Sailing in average up to 5000 m from one survey location to another survey location.
- Positioning of survey vessel at instructed coordinates for boring including all marine operations, navigation, positioning, vessel and accommodation during positioning.

Variation in quantities: -60% +100%

### 3.2 Relocation of survey vessel/jack-up due to CPT (A2.02)

Relocation of survey vessel/jack-up for geotechnical borings at water depths of 5-25 m. from CPT location to borehole location also covers

- Relocation of position in average 1.0 to 2.0 m from the CPT location to drilling location for carrying out the geotechnical drilling.
- Positioning of survey vessel at instructed coordinates for boring including all marine operations, navigation, positioning, vessel and accommodation during positioning.

Variation in quantities: -100% +100%

### 3.3 Relocation of survey vessel/jack-up due to soft soil condition (A2-3)

Relocation of survey vessel/jack-up for geotechnical borings at water depths of 5-25 m. at the same location also covers

- Positioning of survey vessel at instructed coordinates for boring including all marine operations, navigation, positioning, vessel and accommodation during positioning.

If against all odds soft soils are revealed at some of the 5 proposed drilling locations for the present soil investigation and/or positioning is not possible then the following contingency plan shall be valid:

- 1) The vessel is to be relocated 25 m south/east, , where a new drilling is carried out.
- 2) If this new location also shows soft soil condition then the vessel shall be relocated about 25 m north/west to the original drilling location, in direction of the arc for the wind farm.
- 3) If the third location also reveals soft soil conditions then the vessel shall be relocated about 50 m north/west to the original drilling location.
- 4) If the fourth location also reveals soft soil conditions then the vessel shall be relocated about 50 m south/east to the original drilling location.
- 5) If soft soil is also revealed at the fifth position then the wind turbine location is terminated until further notice by the Engineer. A new location will be located for geotechnical investigation before termination of the geotechnical investigation if possible.

Variation in quantities: -100% + 100%

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### 3.4 **Geotechnical borings from 0-10 m depth at 5-25 m water depth (A2-4)**

Geotechnical borings from 0-10 m depth below seabed at 5-25 m water depth also covers

- Dry rotary drilling in soft soil
- Equipment, all necessary spare parts and personnel necessary for the execution including vessels and/or jack-ups.
- Execution of CPT for the length of the drilling except where other tests prevail or undisturbed samplings are executed.
- Environmental sampling of upper 1.0 m below seabed.
- Sampling of disturbed samples each 0.5 m and for each sediment change until end of boring.
- Sampling of undisturbed samples in cohesive soils each 2 m starting from 1.0 m below seabed.
- Shear vane testing is to be executed each 2 m.
- Penetration of stone and boulders in soil
- Filling out approved field book
- Vessels and accommodation during boring operation.

The Contractor will be paid for the length of boring carried out in meter below seabed.

Extraction of remoulded samples can be replaced with undisturbed samples as instructed by the Engineer.

Variation in quantities: -100% + 200%

### 3.5 **Geotechnical borings from 10-50 m depth at 5-25 m water depth (A2-5)**

Geotechnical borings from 10-50 m depth below seabed at 5-25 m water depth also covers

- Dry rotary drilling in soft soil
- Equipment, all necessary spare parts and personnel necessary for the execution including vessels and/or jack-ups.
- Execution of CPT for the length of the drilling except where other tests prevail or undisturbed samplings are executed.
- Sampling of disturbed samples each 0.5 m and for each sediment change until end of boring
- Sampling of undisturbed samples in cohesive soils each 3 m starting from 12 m below seabed.
- Shear vane testing is to be executed each 3 m.
- Penetration of stone and boulders in soil
- Filling out approved field book
- Vessels and accommodation during boring operation.

The Contractor will be paid for the length of boring carried out in meter below seabed.

Extraction of remoulded samples can be replaced with undisturbed samples as instructed by the Engineer.

Variation in quantities: -100% + 100%

### 3.6 Shelby Tube Sample Ø70 mm (A2-6)

The thin walled Shelby Tube shall have a minimum length of 70 cm. Extracted samples shall have a minimum length of 30 cm to be categorised as successful. The Contractor must accept one unsuccessful tube-sample damaged due to stones and/or recovery less than 30 cm at each level. The second attempt to extract one acceptable sample is on the Contractor's expense. In case of friction soils, sand and gravel, the Shelby tube may be replaced with a large bag sample at the discretion of the Engineer.

Variation in quantities: -100% + 100%

### 3.7 Vane shear test - double test with 0.2 m spacing (A2-7)

Execution of down-the-hole Vane shear test at 5-25 m water depth. The test is made after cleaning of the bottom of the borehole for loose soil. Two Vane shear tests are carried out in intact soil under the bottom of the borehole with minimum 0.2 m spacing.

The Contractor will be paid for the number of Vane shear tests carried out. For the payment following test sequence is one Vane shear test:

1. 0.4 m below the bottom of the bore hole one intact and one remoulded test is carried out
2. 0.6 m below bottom of the borehole one intact and one remoulded test is carried out

For soft soils enlarged shear vane shall apply and hence the distance between tests shall be adjusted accordingly.

Variation in quantities: -100% + 100%

### 3.8 Cone penetration test CPT (A2-8)

Execution of down the hole cone Penetration Tests at water depths of 5-25 m. One test is made after cleaning of the bottom of the borehole for loose soil.

The stroke of the DTH CPT can be expected to be maximum 2-4 m. One CPT is to be executed directly at seabed to maximum penetration. This CPT is to be continued until refusal. CPT refusal criterions shall be clearly stated by the Contractor.

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Variation in quantities: -100% + 50%

### 3.9 Vibrocores (A2-9)

Execution of vibrocores at water depths of 5-25 m.

The vibrocore sampler can be deployed and retrieved off the side of the vessel. Vibrocore samples will be described on board to secure the quality of the interpretation of acoustic records. Records shall be kept which include, but are not limited to, digital photograph of sample, sample number, UTM coordinate, water depth, colour, grain size and organic fragments. Selected samples are to be retrieved from all layers and for minimum each 0.5 m of the core. Samples are to be minimum 0.5 kg each, and are to be stored for later possible environmental analysis. Storage of upper 1.0 m samples are to be in diffusion free sample bags (rilsan) and kept cool until handover to the Engineer can take place ashore. Other samples are to be placed in plastic bags.

All samples are to be clearly labelled for unambiguous identification of each sample.

Variation in quantities: -10% + 50%

## 4 Task A, Acceptance of Risks (A3)

The sum of item A3.01 shall be reported at line "A3 Acceptance of risks" in column "Total cost".

### 4.1 Lump sum for acceptance of all risks including weather and sea state for Task A (A3-1)

The sum of costs for acceptance of all risks including weather and sea state for Task A should cover the following

- adverse weather and sea state conditions
- accessibility as a result of adverse weather and sea conditions in excess of safe operating limits
- downtime due to equipment fault, failure or lack
- damaged equipment
- risks associated with the presence on site of munitions/ordnance
- unforeseen ground conditions.

Price adjustment:

Due to possibly significant variations in work and costs for item A1-A2 the actual costs for risks will be adjusted on basis of the actual costs and the cost estimated at tender in accordance with following formula:

$A_A$ =Adjusted sum for work actual carried out, item 2.01-2.03

$A_T$ =Cost at Tender, item 2.01-2.03

$B_T$ =sum of costs A1-A2 at tender

$B_A$ =sum of actual costs estimated on basis of quantities performed under item A1-A2

$$A_A = A_T \cdot \frac{B_A}{B_T}$$

(More work higher risk / less work less risk)

## 5 Task A, Reporting, (A4)

All resources for the execution of reports under Task A, shall be covered by the sum of the cost for item A4.01 to A4.02. The sum of item A4.01 to A4.02 shall be reported at line "A4 Reporting Task A" in column "Total cost".

### 5.1 Factual report preparation in English including (A4-1)

Factual report preparation in English also covers the following

- Description of equipment and limitations
- Coordinates of instructed and actual positions
- Field books from borings and drillings including
  - Field description of soil and rocks
  - Vane shear tests including description and conversion factors
  - Cone Penetration tests including description and conversion factors

### 5.2 Hard Copies of factual report (A4-2)

Includes copies in paper of the factual report.

Variation: -100% +200%

## 6 Task B, Classification Tests (B1)

All resources for the execution of classification tests under Task B, Laboratory Testing, shall be covered by the sum of the costs for item B1.01 to B1.10. The sum of item B1.01 to B1.11 shall be reported at line "B1 Classification tests" in column "Total cost".

All resources for storing of samples for a period of 2 years from completion of final report are to be covered under the items for laboratory testing.

### 6.1 Geological Description of Soil samples, including natural water content (B1-1)

Geological description of each soil sample, including age, sediment and natural water content includes detailed geological description of each soil sample extracted from a boring with matching natural water content. Natural water content shall be determined only in organic, clay and clayey and silty soils.

Variation: -50% +120%

### 6.2 Extra water content, $w$ (B1-2)

Determination of water content,  $w$ , is the price for determination of water content, where required or instructed and this is not a part of another test. The Engineer will decide which samples to perform "Extra water content tests" on.

Variation: -100% +500%

### 6.3 Atterberg Limits, $I_p$ , $w_L$ , $w_P$ (B1-3)

Determination of Atterberg Limits includes execution of laboratory test for Atterberg Limits for fine grained soils and determination of natural water content of the matching sample. The liquidity index is to be reported based on the test results. The Clients rep. will decide which samples to perform "Atterberg Limits tests" on.

Variation: -50% +400%

### 6.4 Specific gravity, $\rho_s$ (B1-4)

Determination of specific gravity (particle density) includes execution of laboratory test for average density of solid constituents. The Engineer will decide which samples to perform "Specific gravity tests" on.

Variation: -100% +200%

### 6.5 Bulk gravity, $\gamma_m$ (B1-5)

Determination of bulk gravity includes execution of laboratory test for average density of intact soil sample including water. Additionally, the natural water content shall be determined in order to estimate the dry gravity. The Engineer will decide which samples to perform "Bulk gravity tests" on.

Variation: -100% +200%

### 6.6 Sieve- & Hydrometer analysis (B1-6)

The purpose of sieve- and hydrometer analysis is to carry out a representative grain size distribution for soils. This includes typical sieve analysis in sand and hydrometer analysis in clay and silt. For soils, which have both clay silt and sand, both tests shall be carried out.

The hydrometer analysis also contain test of specific gravity on a set of representative soil samples i.e. when the specific gravity is tested on a reasonable number of samples on same type of soil, the average specific gravity could be used as an estimated parameter for the test.

The laboratory report shall also report the estimated values Coefficient of Uniformity,  $C_u$  and the Coefficient of Curvature,  $C_c$ . If  $C_u$  is not available, the minimum  $C_u$  shall be stated.

If the soil is none plastic or the Atterberg Limits is carried out at the sample the classification of the soil according to AASHTO and unified classification shall also be estimated and reported.

The Engineer will decide which samples to perform "Sieve & Hydrometer analysis tests" on.

Variation: -100% +200%

### 6.7 Organic content, Loss on Ignition reduced for lime content (B1-7)

Determination of organic content by means of Loss on Ignition includes also test on content of lime or chalk in order to calculate the actual organic content without lime and/or chalk. The Engineer will decide which samples to perform "Organic content, Loss on Ignition reduced for lime content tests" on.

Variation: -100% +400%



## 6.8 Lime content (CaCO<sub>3</sub>) (B1-8)

Lime content (CaCO<sub>3</sub>) determination of the glacial till. The Engineer will decide which samples to perform "Lime content tests" on.

Variation: -100% +400%

## 6.9 Void ratio, e (B1-9)

Determination of the void ratio, e, is the price for determination of void ratio of clay and gravel till and limestone samples, where required or instructed by the Engineer and this is not a part of another test.

Variation: -100% +400%

## 6.10 Void ratio index test on granular soil (B1-10)

Determination of the void ratio index test on granular soil ( $e_{min}/e_{max}$ ), where required or instructed by the Engineer.

Variation: -100% +400%

## 7 Task B, Deformation and strength tests on A-tube or core (B2)

All resources for the execution of Task B2, shall be covered by the sum of the cost for item B2.01 to B2.11. The sum of item B2.01 to B2.11 shall be reported at line B2 Deformation and strength tests on A-tube (Shelby tubes) and core samples under the column "Total cost".

The laboratory reports shall show both digital parameters and when possible graphs of all relevant factual parameters. The form and examples of estimated design parameters shall be approved by the Engineer before final reporting.

### 7.1 CAU Triaxial Test. Anisotropic consolidated undrained (B2-1)

Execution and reporting of anisotropic consolidated undrained triaxial test carried out on Ø70 mm intact soil samples (Shelby tubes or core samples) in accordance with instructions from the Engineer

Variation: -100% +400%

**7.2 MCAU Triaxial Test. Multi stage anisotropic consolidated undrained (B2-2)**

Execution and reporting of multistage anisotropic consolidated undrained triaxial test carried out on Ø70 mm intact soil samples (or core samples) in accordance with instructions from the Employers representative.

Variation: -100% +300%

**7.3 CIU Triaxial Test. Isotropic consolidated undrained (B2-3)**

Execution and reporting of isotropic consolidated undrained triaxial test carried out on Ø70 mm intact soil samples (Shelby tubes or core samples) in accordance with instructions from the Employers representative.

Variation: -100% +400%

**7.4 MCIU Triaxial Test. Multistage isotropic consolidated undrained (B2-4)**

Execution and reporting of multistage isotropic consolidated undrained triaxial test carried out on Ø70 mm intact soil samples (Shelby tubes or core samples) in accordance with instructions from the Employers representative.

Variation: -100% +400%

**7.5 CID Triaxial Test. Isotropic consolidated drained (B2-5)**

Execution and reporting of isotropic consolidated drained triaxial tests on intact samples in accordance with instructions from the Employers representative.

Variation: -100% +400%

**7.6 MCID Triaxial Test. Multistage isotropic consolidated drained (B2-6)**

Execution and reporting of multistage isotropic consolidated drained triaxial tests on intact samples in accordance with instructions from the Employers representative.

Variation: -100% +400%

**7.7 Oedometer test. Incremental loads. Including one unload and reload cycle (B2-7)**

Execution and reporting of Oedometer test with incremental loads on Ø70 mm sample (or core samples) including one unload and reload cycle in accordance with instructions from the Engineer.

Variation: -100% +200%

**7.8 Oedometer test. Additional costs for 3 cycles - unload and reload (B2-8)**

Execution and reporting of additional unload and reload cycles for Oedometer test with incremental loads on Ø70 mm samples (or core samples) in accordance with instructions from the Engineer.

Variation: -100% +400%

**8 Task B, Reporting (B3)**

All resources for the execution of reports under Task B, shall be covered by the sum of the cost for item B3.01 to B3.02. The sum of item B3.01 to B3.02 shall be reported at line "B3 Reporting Task B" in column "Total cost".

**8.1 Factual report preparation in English (B3-1)**

This item covers preparation of boring profiles made on basis of the field books from Task A and the classification tests including geological descriptions of each sample made under this Task as well as preparation of factual report on basis of boring profiles and other laboratory tests carried out. The factual report shall summarize the results of the laboratory tests.

One copy of the report including drawings and enclosures shall be made in the PDF-format. Well separated, another copy of all the documents shall be made in its original form. On request the Employer can ask for a copy of selected raw data in other standard formats.

A copy of the project documentation shall be made in hard disc for the Employer.

**8.2 Hard Copies of Factual Report (B3-2)**

Print of the factual Report in paper.

## 9 Task C, Interpretative Reporting (C1)

All resources for the execution of reports under Task C, shall be covered by the sum of the cost for item C1.01 to C1.02. The sum of item C1.01 to C1.02 shall be reported at line "C1 Interpretative Reporting" in column "Total cost".

### 9.1 Interpretative report on Geotechnical Design Parameters for W.T. positions. (C1-1)

Interpretative report preparation on basis of factual reports from Task A and B.

This item covers preparation of geotechnical design parameters for a gravity based foundation for a 3.6 MW - 8 MW Wind Turbine.

The report shall clarify the correlations between the results reported in the boring profile, laboratory tests, CPT-tests, geological survey from 2009 i.e. reported in year 2016 and the design parameters.

One copy of the report shall be made in the PDF-format. Well separated, another copy of all the documents shall be made in its original form. On request the Employer can ask for a copy of selected raw data in other standard formats.

A copy of the project documentation shall be made in hard disc for the Employer.

### 9.2 Hard Copies of Factual Report (C1-2)

Print of the factual report in paper. Number of copies: 5