

## DETAILED SPECIFICATION OF THE SUBJECT MATTER OF THE AGREEMENT

1. The subject of the order is the delivery of optical sensors with installation in a floating dock at the Myklebust Verft AS Shipyard in Norway.

Designation according to the CPV dictionary:

38410000-2	Metering instruments
38412000-6	Thermometers
38425500-5	Strength estimation apparatus
32562000-0	Optical-fibre cables
45262680-1	Welding
45314300-4	Installation of cable infrastructure
45314310-7	Installation of cable laying
51210000-7	Installation services of measuring equipment
51230000-3	Installation services of testing equipment

2. The order is co-financed by the National Center for Research and Development, the EEA Financial Mechanism and the Norwegian Financial Mechanism for 2014-2021 as part of the research project entitled "A Floating Dock Digital Twin towards Efficient, Safer and Autonomous Docking Operations" implemented as part of the POLNOR 2019 Call program, contract number: NOR / POLNOR / DigiFloDock / 0009 / 2019-00.
3. The order is for the purposes of carrying out a research project. The subject of the order are supplies and services used solely for the purposes of research, experimental, scientific or development works, which are not used by the Ordering Party to conduct mass production aimed at achieving market profitability or covering the costs of research or development.
4. The reason of this order is to build a measurement system that will allow to measure and record the strains of the dock hull during docking operations. Installation works are to be performed on a floating dock at Myklebust Verft shipyard in Gursken, Norway.

The measurement system will consist of 5 measurement points, a device for reading data from sensors (interrogator) and a PC for collecting and recording data from the interrogator. 4 measurement points will be located inside the ballast tanks in the double bottom and one below the Upper Deck. This order includes the renting of an interrogator within the time limits specified in point 9.3 of this specification. The PC is not included in the order, the Ordering Party will use its own device to collect and record data from the interrogator.

The measurement system will function during dock operations, so it must be suitable for installation in ballast tanks and must be resistant to factors such as seawater, water pressure, vibration and any other factors that occur during normal dock operations.

Each of the four measuring points inside the double bottom ballast tanks will contain two temperature sensors, two strain gauge rosettes and one single strain gauge. One rosette system will be mounted in the mid height of the transverse floor, one rosette system will be mounted in the mid height of the of CL

girder, and one temperature sensor with a single strain gauge will be mounted on the transverse floor under the Main Deck.

The measuring point under the Upper Deck will contain three strain gauges and one temperature sensor mounted below the Upper Deck on the port side of the dock.

The interrogator with a safety box will be located in the corridor on the Safety Deck amidships, on the port side.

The sensors at each of the four measuring points inside the double bottom ballast tanks shall be connected in series in the following order:

Interrogator → rosette of 3 strain sensors on CL girder → temperature sensor on transverse floor → rosette of 3 strain sensors on transverse floor → temperature sensor on transverse floor under Main Deck → single strain sensor on transverse floor under Main Deck → Interrogator

The measurement sensors under the Upper Deck will be connected in series to the interrogator in the following order:

Interrogator → strain gauge under Upper Deck fr. 117-118 → temperature sensor under Upper Deck → strain gauge under Upper Deck fr. 60-61 → strain gauge under Upper Deck fr. 174-175 → Interrogator

All sensors must be connected to the interrogator with lead-in and lead-out armored fiber patch cables.

Location and arrangement of sensors according to drawing “106-001 Arrangement of sensors”.

THE SCOPE OF WORK includes, inter alia:

- a) Installation of strain gauges and temperature sensors according to drawing “106-001 Arrangement of sensors” and sensor assembly instructions.
- b) Determining, in agreement with the shipyard, the exact route of the cables from the sensors to the interrogator. When determining the route of cables, one should take into account such elements as, among others, the shortest cable lengths, the use of existing cable trays, convenient places for mounting cable passages.
- c) Prefabrication, assembly and welding inside ballast tanks of cable supports made of stainless steel bars (AISI 316L) according to drawing “106-001 Arrangement of sensors”. The exact location of the cable supports should be determined after agreeing the route of the cables from the sensors to the interrogator.
- d) Installation and welding of watertight cable glands on the bulkheads of ballast tanks according to “106-001 Arrangement of sensors”. Exact positions of the glands should be determined on the spot, after agreeing on the route of the cables. Before installing the cable passage, check the situation on both sides of the bulkhead to avoid damage to equipment that may be on the other side.
- e) Installation and welding of watertight multi-cable passages on bulkheads and decks outside watertight tanks acc. to “106-001 Arrangement of sensors”. The cable passages should be tight at a pressure of up to 4 bar. Before installing the cable passages, check the situation on both sides of the bulkhead to avoid damage to equipment that may be on the other side.

- f) Repair any damaged paintwork after completing all hot work and before pulling cables.
- g) Preparation of the site for the installation of the box for the data acquisition device (interrogator) on Safety Deck, including the supply of power and Ethernet LAN to this site.
- h) Pulling fiber optic cables between sensors and interrogator according to “106-001 Arrangement of sensors”. Be especially careful when pulling the fiber optic cable so as not to damage it.
- i) Fastening cables to cable supports. Inside the ballast tanks, the cables are to be attached to the previously installed cable supports. Apart from the tanks, the existing tracks and cable supports should be used.
- j) Connecting cables to sensors.
- k) Connecting the cables to the interrogator.
- l) Testing the system to confirm that all sensors have received correct signals.

All work in the dock must be agreed with the owner - Myklebust Verft AS shipyard.

The safety of workers and equipment must be ensured during all work.

The contractor must provide all necessary materials, equipment, scaffolding and tools needed to perform the described works.

5. The order includes the following parts (stages):

**5.1. delivery of the optical sensors and cabling that conform to the following specification:**

1	optical strain gauges	resolution of at least 0.5 [ $\mu\text{m}/\text{m}$ ], range from -5000 to +5000[ $\mu\text{m}/\text{m}$ ] dimensions not exceeding 110 [mm] x 25 [mm] x 10 [mm]	31 pcs
2	optical thermometers	resolution of at least 0.02 [ $^{\circ}\text{C}$ ], range from -20 to +80 [ $^{\circ}\text{C}$ ] dimensions not exceeding 110 [mm] x 25 [mm] x 10 [mm]	11 pcs
3	fiber optic cable	divided into 5 segments terminated with connectors at the ends to connect 5 groups of sensors with data acquisition device (interrogator)	1520 [m]
4	waterproof connectors to connect fiber optic cables and sensors	assured to enable proper functioning of the entire installation submerged in seawater at a depth of at least 12 m	

a) Sensors, fiber optic cable and connectors shall be able to function properly under continuous immersion in seawater at a depth of at least 12 m for at least 2 years.

- b) Due to the necessity to minimize cable penetrations through watertight bulkheads of floating dock ballast tanks, sensors must be connected in series with at least 10 sensors on one fiber optic cable, led to the device collecting measurement results.
- c) Due to the nature of the measurements, the frequency of reading indications from all sensors must be at least 2.0 [kHz].
- d) The contracting authority requires the contractor to submit, along with the offer, documents confirming that the offered deliveries meet the requirements specified by the contracting authority, i.e. the technical documentation of the offered optical strain gauges and optical thermometers. Technical documentation is understood as e.g. catalog cards, technical specifications provided by producers and distributors or own descriptions drawn up by the Contractor on their basis, together with an indication of the sources of the information presented, e.g. own source, manufacturer's or distributor's website address, containing a description of the product . The contracting authority accepts equivalent means of proof if they confirm that the offered supplies meet the requirements, features or criteria specified by the contracting authority.

## 5.2. sensors' installation service in the floating dock in Norway

Works related to the implementation of the contract include the implementation of at least the following scope, and are to be carried out in accordance with the drawing constituting Annex 3a to this specification:

- a) correct attachment of optical sensors to steel elements of the dock structure inside three ballast tanks (+ passing two ballast tanks with cable), enabling correct reading of measurement results and identification of sensors
- b) proper protection of the installed optical sensors against environmental influences (temperature, pressure and seawater) lasting for at least 2 years
- c) serial connection of sensors with fiber optic cables inside ballast tanks, attaching fiber optic cables to the elements of the dock structure and securing connections against the influence of seawater, temperature and pressure
- d) making watertight passages through the bulkheads of ballast tanks of thickness 10 mm to 12 mm and routing fiber optic cables from sensors connected in series - watertight passages must be designed to work without any leakage under a continuous pressure of at least 15 bar (gas and water) and be fireproof
- e) confirming the tightness of ballast tanks after making watertight passages and passing optical cables through them by performing tests - the tightness test should be performed by increasing the air pressure in the closed tank by 0.2 bar and checking the tightness of the installed watertight passages with a soapy solution (this is Contractor's duty to provide a compressor of appropriate parameters to keep the increased pressure inside a tank for the duration of at least 1 hour as well as to provide necessary accessories)
- f) correct mounting of optical sensors under the upper deck of the dock, enabling the correct reading of measurement results, identification of sensors and protection against environmental influences (external weather conditions, temperature and internal conditions in the dock)

- g) routing optical fiber cables in spaces not flooded with water to the collecting point under the control room of the dock and fixing them to the elements of the dock structure - all penetrations through watertight bulkheads of thickness 10 mm to 12 mm should be made with the use of cable passages that allow to maintain tightness at a pressure of 2.6 bar (gases) and 4 bars (water) and be fireproof (at least class EI 120)
- h) preparation of the site, power supply and connection to the Ethernet LAN network for the box for the device for collecting data from sensors and preparation of fiber optic cables for insertion into this box, as well as identification of sensors on the cables
- i) cleaning the surface (in accordance with ISO St3) and supplementing the paint coatings after the assembly works on all surfaces damaged during the works. The following coatings are currently used on the dock:
  - 1 layer 40 my Intergard 269
  - 1 layer 150 my Intershield 300 bronze
  - 1 layer 150 my Intershield 300 aluThe Contractor must use compatible coatings ensuring at least the same durability and functionality as the above-mentioned currently used in the dock.
- j) confirmation of the correct operation of optical sensors in tanks and under the upper deck of the dock by conducting tests consisting in:
  - test reading of data from sensors
  - checking the thermal creep of strain gauges
  - the Ordering Party also allows the test of strain gauges with the use of an additional load, provided that the owner of the dock has an appropriate load.

The Contractor provides cables, technical gases, tools and scaffolding necessary to perform the above-mentioned works on his own. Due to the possible performance of works in low temperature conditions, the Contractor should provide two heaters with a capacity of at least 80kW together with accessories that will enable the simultaneous increase of the temperature by 10 degrees Celsius in two tanks with a volume of approx. 2000 m<sup>3</sup> each.

The Ordering Authority informs that Myklebust Verft AS is the owner and administrator of the dock, therefore all works will be supervised by the owner of the dock, and all risks concerning possible exceeding the deadline for sensor installation stated in the contract shall be borne by the Contractor. By submitting the offer and signing the contract, the Contractor assumes responsibility for all arrangements with the owner of the dock in terms of dates and periods of access to the dock, while declaring that these arrangements will always aim at the proper and timely performance of the contract.

Before starting the works, the Contractor is obliged to take a HSE (Health, Safety and Environment) training organized by Myklebust Verft AS. The form and date of the training to be agreed with the representative of Myklebust Verft AS.

**5.3. the provision of a device for collecting data from sensors with a box for a period of 14 calendar days within 6 months from the date of completion of the sensor assembly service in the dock in order to conduct additional tests.**

- 6. In the event of any discrepancies between the order documents, each time an inquiry should be submitted to the Ordering Party in order to clarify the doubts. The contracting authority will indicate the manner of further proceedings.

7. The offer submitted by the Contractor must be unambiguous and comprehensive, i.e. cover the entire subject of this. In order to achieve all the intended goals and requirements set by the Ordering Party, in particular in the Description of the Subject of the Order, the subject of the contract offered by the Contractor must be complete with all subassemblies, parts and materials necessary for commissioning and carrying out tests. The offered subject of the contract must meet all the requirements of the Ordering Party. After installation and commissioning, the delivered subject of the contract must be ready for operation in accordance with its intended purpose and the purpose designated by the Ordering Party, without additional investment purchases on the part of the Ordering Party. At the stage of the contract, the Contractor performs the subject of the contract in accordance with the requirements of the Ordering Party. The contractor carries out the subject of the contract with his own means.
8. Due to the particularly difficult working conditions and the need to immediately respond to signals from the owner of the dock (e.g. evacuation call), persons performing the assembly service must have fluent knowledge of the English or Norwegian language or be provided with ongoing translation services of a professional Norwegian translator.

### 9. Deadlines and place of order fulfillment:

Due to the specificity of the subject of the contract, the Ordering Party requires the contract to be completed in the following parts (stages):

#### 9.1. delivery of the optical sensors

The specified optical sensors, fiber optic cable and connectors are to be delivered to Myklebust Verft AS Shipyard in Norway, Gurskevegen 68, 6082 Gursken - **within 70 days from the date of the contract.**

#### 9.2. sensors' installation service

a) the specified optical sensors installation service is to be performed at the premises of Myklebust Verft AS Shipyard in Norway, Gurskevegen 68, 6082 Gursken, in a floating dock located there.

b) deadline for the performance of the service:

i) the scope specified in point 5.2. from a) to e) and i) of this specification: the assembly service will be performed **within 6 working days between April 15, 2022 and October 30, 2022.** Due to the uncertainty of breaks in the floating dock's work, with a specific date of commencement of assembly works at the dock, which will take place within the time interval specified above, the Contractor will be informed at least 72 hours before that date. The service performance time may not exceed 6 business days.

ii) the scope specified in point 5.2. from f) to j) of this specification: not later than **10 days from the commencement of the provision of the service specified above (in point 9.2 b) i) of this specification).**

9.3. providing a device for collecting data from sensors with a box for a period of 14 calendar days within 6 months from the date of completion of the sensor assembly service in the dock in order to conduct additional tests.